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Check Dams

MR. OLMSTED'S article, on page 636 of this issue, recounts observations on a combination flood-control and water-conservation scheme being tried out in the mountains near Los Angeles. Check dams are not new in engineering practice, though they have not, so far as is known, been applied heretofore in the United States. In central Europe—Switzerland and Austria—their merits have long been known. Two objects are aimed at in their construction—the impeding of the flow, thus cutting down erosion, and the forcing of flood waters into underground storage so that they will become available in the dry season. So far, observations on the system of check dams near Los Angeles have been most encouraging. Should records of future years substantiate present promise they may take a very important position in the water-conservation and flood-protection practice in those parts of our country where mountain slopes are steep and reservoir sites not available.

Trainmen's Demands

IT HAS BEEN repeatedly pointed out that since the Interstate Commerce Commission controls the income of railroads it should have something to say about the outgo. The thought is particularly pertinent at the present time when the trainmen are making demands for a 25-per cent wage increase. If granted, these demands would add about $330,000,000 a year to the railroad wage bill. If the controversy should be arbitrated as in the past, by a body independent of the Interstate Commerce Commission, some advance may be given the trainmen, without any consideration of the sources from which the necessary funds will come. Seeing the logic of the situation, the Chamber of Commerce of the United States has proposed that the Interstate Commerce Commission be directed to make an investigation of the controversy. Such a proposal is hard on the Interstate Commerce Commission; it certainly has enough work without taking up this angle of railroad affairs. Nevertheless, the logic of the proposal is irresistible. The big question is whether or not Congress can be made to see it.

Convenient Code Arrangement

NEW YORK CITY has just issued in the form of a booklet the revised building code containing all revisions passed by the Board of Aldermen up to Dec. 14, 1915. Conforming with one of the principles in the revision laid down by Rudolph P. Miller, consulting engineer to the committee, the new code is exceptionally well arranged. Furthermore, it is clearly and completely indexed. In the form just compiled and indexed by Robert B. Insley, assistant superintendent of the bureau of buildings, Borough of Manhattan, any desired regulation on any detail of construction can be instantly located. Aside from the many improvements accomplished in the revision, both in content and in technical form and quality, already commented upon in an editorial on page 35 of the issue of Jan. 8, the new code marks a great advance in the publication of building regulations as practised by cities in this country. That the great waste of time experienced in the past in locating regulations on any given detail of construction is entirely unnecessary and can be completely eliminated is clearly demonstrated by the present form of New York's code.

Commissions and Maximum Rates

THAT the New York Public Service Commission need not be hampered in rate regulation by the maximum rates fixed by the general railroad law has now been established by a decision of the Court of Appeals in the Ulster & Delaware case. Readers of the Engineering Record will recall that last year (see the issue of August 21, 1915, page 226) W. J. Wilgus, consulting engineer, presented abundant proof to the commission that the 2-cent mileage rate which the Ulster & Delaware Railroad was compelled to make meant passenger service at less than cost; but that the commission, while admitting the force of the argument, ruled that it was not empowered to allow a rate higher than the 2 cents per mile prescribed by statute for mileage tickets. In February of this year the Appellate Division of the state Supreme Court overruled this decision. Now the Court of Appeals sustains the Appellate Division, and the commission has responded by authorizing the railroad to increase its mileage rate from 2 to 2.9 cents per mile, only a tenth less than the 3-cent rate asked for by the railroad. The decision proves that in New York State, at least, the purpose of the regulatory body is to regulate rates either upward or downward as justice demands, and not merely to scale them down to the lowest possible figure.

Anti-Mosquito Entente

AN ANTI-MOSQUITO ENTENTE has been formed by health authorities in New Jersey, Connecticut, Long Island and Westchester County, N. Y. A week has been set aside for the opening of the campaign, during which there will be carried on vigorous educational as well as actual work. Arrangements have been made for widespread draining and oiling of salt marshes, pools, swamps and other mosquito-breeding places. In connection with the campaign, literature is being furnished to the daily newspapers throughout the sections affected, and excellent work is thus being done in distributing information as to ways of killing the wrigglers from which the mosquitoes develop. The entente is necessary for effective anti-mosquito work. It is of little value to have one county drain its marsh lands and oil its pools, if the adjacent counties do nothing. Only by combination of all of the forces in a badly affected district can success be attained. For years the communities around New York have been carrying on their own extermination work. The results have been fair. There is now reason to believe that, through the effective combination of all of the mosquito-fighting forces, the metropolitan district may be entirely freed of the pest.

Water Pipe and Street Grades

IF AN engineer engaged in municipal work fails to look well into the future in planning his construction he or his successor will meet with many unforeseen difficulties. A case in point, which should appeal particularly to waterworks men, is cited by H. P. Bohmann in the latest annual report of the Milwaukee waterworks. The distribution division in this city has been put to considerable expense during the past year on account of the necessity of lowering water pipe and service connections in streets where the pipe and services had been laid before the grade of the street was established. Evidently this pipe was laid without any regard to a future grade. In one instance the water pipe was left on top of the street after the street was cut down to the established elevation. No water pipe should be laid unless the grade is established, or a tentative grade is fixed by the city engineer. It should not be necessary to lower the water pipe if the street is brought to grade. With this in view some of the new pipe laid in Milwaukee during the past year where the grade was not yet established was placed with from 8 to 12 ft. of covering. This is an instance of how municipal departments can co-operate and save money for the taxpayers.

Posed Construction Pictures

WITH the approach of summer comes the open season for picture-taking. Engineers in greater numbers than ever before are equipping themselves with hand cameras to record the progress of their work and interesting details of construction which it would often take a page or two of text to describe. Many of these views, however, are spoiled, pictorially, by having the working force "pose" while the shutter is being snapped. Take the case, for example, of laborers placing concrete in forms. When a picture is suggested there appears to be an overpowering desire on the part of the inexperienced camera operator to line these men up in front of their work and summon as many extra members as can be accommodated on the film. Then when the members of the group, on dress parade, have assumed the usual self-conscious facial expressions, the exposure is made. The finished picture gives no idea of the distribution of the force under actual working conditions and the posed line of men often completely eclipses some interesting plant detail. Then, too, there is an atmosphere of artificiality about such a photograph which robs it of its interest. Don't have a construction gang pose for a picture. Snap them in action.

Winter Heaving of Pavements

MUNICIPAL engineers who are responsible for the condition of paved streets will profit by a study of the experiences of Seattle and other Pacific Coast cities, as recited by J. Thomas Dovey on page 640. An unusually long period of cold weather early this year, coupled with the presence of water below the street surface, is given as the primary cause of the damage. An examination of conditions in a number of cities indicated that the trouble was not confined to pavements of any one type. Brick, asphalt and wood block all showed the effects of frost action. One point which the investigations revealed was that the heaving occurred only on streets which carried street-railway tracks and that the damage was greatest adjacent to the rails. Mr. Dovey believes that the remedy is proper drainage and a filler which forms a tight bond between the rails and the paving material. If water is allowed to enter a joint at this place an ice filler is formed, causing a movement upward of the paving blocks, due to the expansion of the water in freezing. The consequences are more serious than the mere production of a rough and unsightly street surface. One case is mentioned in which the heaving amounted to as much as 5 in., sufficient to block the passage of street cars. In another case a long section of blocks adjacent to the rails had to be removed to give the cars proper clearance. Where the blocks were not taken out their tops were pounded and broken. The bond between the rails and the paving blocks appears to be the key to the situation. It would be interesting to hear how engineers in other cities have dealt with this problem. A discussion would be of great value.

Sunday for Contractors, Too

SUNDAY work does not meet the approval of H. P. Converse & Company and of G. M. Follett, their superintendent on the Hanover Street bridge. They recognize the fact that a man is capable of doing just so much in a given length of time, and that if he is worked continuously the amount will be cut down. As a result a long contract, described on another page of this issue, is reaching an end with everybody fresh and doing his share. Although unusual difficulties arose to try the patience of superintendent, foreman and workman alike, there are no malcontents. The organization, in fact, is completing its third large contract with scarcely a change of personnel. There is work, such as pneumatic caisson construction, where to stop even a day is costly and attended with possibility of disaster. Nevertheless, without any increase in the total labor cost, enough men can be employed in such work to give each a chance to lay off a day at intervals and renew his energy. With men in authority this is harder to arrange, but even still more important. At the end of months of ceaseless effort to keep work going smoothly even an able man reaches a state of exhaustion where mistakes are to be expected. Because of his responsible position, such mistakes will always be costly. Usually they would more than pay for the assistance needed to relieve the strain which caused them. Many contractors have already found that seven days a week for every man on the job pays no extra dividends and breaks no progress records.

Ton-Miles or Maximum Loads

ON PAGE 639 Paul M. LaBach makes an interesting contribution to the meager literature on the allocation of railroad maintenance expenses to passenger and freight service. His main ideas are that maximum loads, which determine the design of railroad structures, should have more bearing than actual ton-miles on the items affected by traffic; that the items not affected by traffic constitute a large percentage of the total, and that these are likely to be overlooked in the determining of fair return.

As to the latter two contentions, the Engineering Record believes with Mr. LaBach that there is danger that in the alternate revision downward of freight and passenger rates items not directly dependent on traffic may be overlooked. One may doubt, however, whether $K - A$, as defined by Mr. LaBach, should be divided into two equal parts as he proposes, rather than according to the traffic; and whether a uniform figure of $800 should be used for $K - A$ for all of the roads in Table 2—in other words, whether the prosperity factor B, and perhaps to some extent the factors C and D, should not vary according to the percentage of passenger traffic.

Regarding the use of maximum loads instead of ton-miles in the subdividing of Mr. LaBach's $fx + py$, there is a chance for debate, and perhaps a combination of the two theories might be the ultimate solution. Surely there is force in his argument as applied to bridges, which are designed for maximum equipment and impact, and are not affected as to deterioration by the frequency of loads well under the elastic limit. But the theory does not seem to fit track so well. Until the special committee on stresses in track makes a full report, this journal cannot subscribe to Mr. LaBach's statement that track is designed to carry its maximum loads. It appears rather that trial is the main guide in the design of track, and that nobody can yet say positively whether the greatest stresses therein are produced by maximum loads, excessive speeds or flat wheels. Certainly defective equipment affects maintenance, and multiplies with traffic. The subject is a complex one, however, and the Engineering Record would gladly throw its columns open to discussions of the problem by those who have given it thought.

High Stresses in Flat Slabs

CONVINCING evidence that the factor of safety of the flat-slab floor construction of the Seattle port warehouse is exceedingly low is found in the high local stresses in both steel and concrete obtained in the test made for the Seattle building department. As reported by Mr. Hooker in the article on page 647 of this issue, dangerously high unit stresses correspond to the extensometer strains measured under a final test load only 1.1 times the sum of the dead and design live loads, or 1.4 times the design live load. The words "dangerously high" are fully justified. Under this relatively low test load—the Chicago code requires a test load sufficient to double the total design load—steel rods of 50,000-lb. elastic limit were stressed nearly to that limit, and stresses were obtained in the concrete exceeding the average ultimate strength of test cylinders of the same age. Numerous cracks in many directions in both top and bottom of slabs and continued deformation and deflection under the final load, which was left in place for 84 hr., together with large permanent sets and deflections after the load was entirely removed, were observed. The maximum deflection of 0.8 in. was 1/300 of the span—the Chicago code limit is only 1/800.

This evidence throws light upon the flat-slab controversy waged between the proponents of this system and the more conservative engineers. No theory of least work or long mathematical dissertations leading to an adoption of an arbitrary value of 0.5 for Poisson's ratio for reinforced concrete can refute the facts presented, provided the tests were accurate, and Dean Fuller's standing vouched for this.

This test demonstrates anew the advantage of actual strain measurements, made at carefully selected points on floors and columns, over simple load and deflection tests. The ability to locate and measure the overstressed parts by this method of field investigation is of the greatest help in reaching an understanding of stress distribution and in suggesting improvements in design. In this case the possibility of a more economical distribution of the reinforcing steel is indicated; the compression in the outer ring over column 19 and the cracks in the concrete over the direct bands between columns point to weakness due to improper proportions of steel in the diagonal and direct bands or to improper spacing. The loading of the two wall panels only, a type of test advocated by many engineers, showed strikingly the relatively high stresses possible for this case. It is stated that the stresses in portions of these panels under full live load would probably be as great as those produced by one-and-one-half live load over the entire floor.

The concrete engineer who has consistently kept to conservative practice in the design of flat slabs, neglecting the tensile value of the concrete and recognizing no excess "bond-shear" strength element, will find that the results of this test confirm the view that safe and permanent construction must be based upon the standard bending-moment formulas which the majority of engineers has advocated.

Cleveland's Sewage Report

THE DEGREE to which sanitary engineers are adapting the design of sewage-treatment plants to local conditions is well illustrated by the case of Cleveland, Ohio, where three separate works, each differing from the others in the details of disposal methods, were recommended in a joint report by Robert Hoffman, chief engineer, R. Winthrop Pratt, consulting engineer, and Harry B. Hommon, chief chemist. The conclusions are particularly valuable, for they are based upon about two years' operating results obtained at a testing station where various devices and processes were studied. Although the report has just been issued in printed form its recommendations have, in part, been put into effect, and one of the Cleveland plants was described in the Engineering Record of March 25, page 408.

In the design of sewage-treatment plants two basic factors must be given equal consideration—the composition of the raw sewage and the character of the body of water which is to receive the effluent. The Cleveland report reflects the careful study which has been given to both subjects. About half of the city's liquid wastes is discharged into Lake Erie, while the remainder enters the Cuyahoga River. In the case of the largest of the three installations —the easterly works for the Lake Erie effluent—the plant recommended includes grit chambers, two-story settling tanks, disinfection apparatus and a dispersing outlet. Here the principle governing the design was the desire to secure only clarification of the sewage, together with provision for disinfection and dispersion of the effluent.

At the southerly plant, which will discharge into the Cuyahoga River, a nonputrescible effluent was demanded, as the flow of the river is not sufficient, at all times, to oxidize a large quantity of tank-treated sewage. At the southerly works, therefore, the process used at the easterly plant is altered by the addition of coarse-grained slag filters and the omission of the disinfecting feature.

At the westerly works the important factor was that land ultimately available for sewage treatment purposes is quite limited and that the sewage in this locality is fresher than that discharging at the easterly works. These conditions made the clarification of the sewage by fine screening appear more suitable than tank treatment.

It is apparent from this brief outline of the report that no "standard" sewage plant could have been applied, economically, to the solution of Cleveland's problem. Similar conditions are presented at Philadelphia, where a number of plants have been designed with particular reference to local requirements and conditions.

An interesting feature of the report is the suggestion of inclosed sludge-drying beds at Cleveland. This type of bed, the report states, can be operated through the entire year, provided a heating system is installed to prevent freezing during winter. In summer the period of drying is approximately the same as, or possibly a little longer than, with open beds. Eliminating the three winter months of operation it is possible to operate beds of this type so that 1 sq. yd. of surface will dry 0.8 cu. yd. of sludge per year.

From what has been said the value of the report as a contribution to sewage-treatment literature is evident.

The Waste at Niagara

TWO WEEKS AGO at its meeting in Washington the American Electrochemical Society devoted a session to a symposium on Niagara Falls and the industries there dependent on hydroelectric power. The situation depicted is of national import. Briefly the situation is that the electrochemical industries are unable to get the power needed for their continued expansion. The restrictions placed both by treaty and by government rulings, unless modified, are certain to force these industries to move to Canada or even to Europe for their further power needs. In a word, there is danger that industries which their promoters are anxious to develop to large proportions on American soil will be expatriated and the strength which they might add to the national wealth and national resources be lost. In fact, American capital, unable to secure development rights in this country on a sound business basis, is now employed on the Canadian side of the Niagara frontier, and some of it is even working in the Scandinavian peninsula. There is but one alternative to further migration of capital for electrochemical activity—the enactment of favorable water power laws and the granting of further withdrawals of water at Niagara.

The treaty between the United States and Great Britain covering the Niagara situation, which went into effect in May, 1910, allows the diversion of 56,000 sec. ft., 26 per cent of the average flow of the river. Of this quantity, 20,000 sec. ft. is for American and 36,000 for Canadian use. The United States Government, however, has persistently refused to grant permits for more than 15,600 sec. ft. (part of this goes to the Erie Canal), so that every second 4400 cu. ft. of water, capable of generating 80,000 hp., goes to waste. The power actually developed on the American side is about 215,000 hp.

In Canada 29,000 sec. ft. (including that for the Welland Canal) is used, and 360,000 hp. is developed. Of this amount 175,000 hp. is transmitted to the United States, which is nearly up to the limit permitted by Canadian law.

The variety of plants at Niagara dependent upon electrical power are little appreciated except by those in touch with the chemical and metallurgical industries. Up to the present time the total domestic production of ferro-silicon, employed as the chief deoxidizing agent in the production of finished steel, has been made from Niagara power. The commercial development of aluminum was first made possible at Niagara, and, in fact, the Falls district was for many years the only seat of the industry. Five plants there are engaged in the making of electric-furnace abrasives—carborundum and aluminum—while calcium carbide, artificial graphite, chlorine, caustic soda, caustic potash, metallic sodium and phosphorus are also produced in large volume. It requires but a small acquaintance with the chemical, metallurgical and engineering arts to understand the wide influence upon our industries of these products.

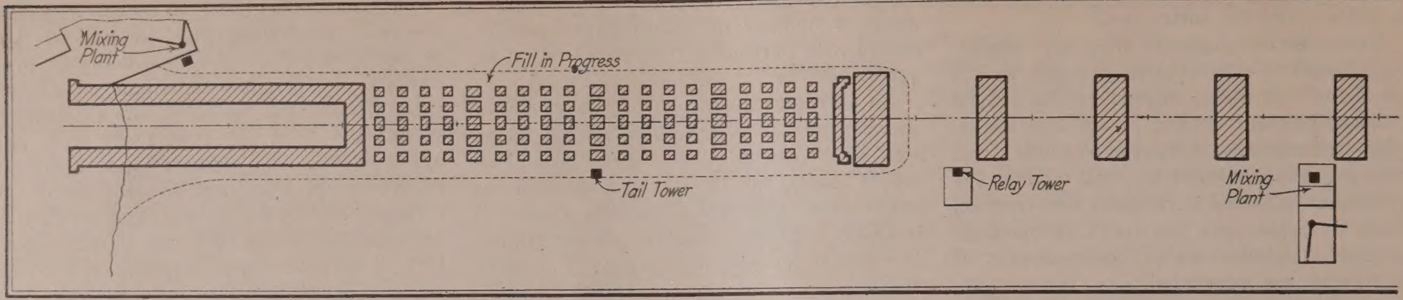
The European War has taught us more clearly than ever before how serious it is to have a one-sided industrial development, and to depend upon foreign nations for materials of great, even if not of vital, importance to the nation's life. There may be products, of course, in which the economics of the situation are such as to warrant only limited development in this country, but all of those mentioned as being produced at Niagara Falls can readily be made here on a sound economic basis. It is the part of folly, then, for the nation for the sake of a fetish—scenic preservation—to force to other lands industries that can be economically developed here and whose promoters prefer to remain on American soil.

Condemnation of those who favor increased withdrawals of water from Niagara have been common. "Nature robbers," "gross materialists" and similar hard names have been applied to them. If Niagara Falls were the only spot in the United States where its people could enjoy the beauties of nature, there might be some warrant for the characterization. When, however, nature has been most lavish in the quantity and disposition of her treasures it is a mawkish sentimentality that allows over 3,000,000 hp. to go to waste, at a cost, it has been carefully estimated, of something like $100 per look for each visitor to the Falls.

No one will deny that the spectacle is sublime, most impressive, but certainly ways can be devised to allow the full flow to go over the precipice at intervals. Certain Sundays might be set apart, for example, or all of the industries might take a two week's vacation in the summer, turning the full flow into its natural channels.

This journal does not doubt in the least that the time will come when economic pressure will be so great that it will be impossible to let Niagara go unused. But why should the waste be allowed to go on now and for many years hence, when the argument is overwhelmingly in favor of the use of the cataract?

Engineers are expected to think soundly on such matters. Is it not time that their national societies took up the matter actively and presented it to the people of the United States, to the end that Niagara would be the servant and not merely the entertainer of mankind?



Well-Balanced Mixing Plants Pour Dense Concrete from High Towers on Long Highway Bridge

Carpenter Work Sets Pace on Baltimore Structure Where Pier Sites Were Excavated and Piles Driven and Cut Off Before Steel Coffers Were Built—40,000 Yards of Concrete Require 2485 Tons of Reinforcing Steel

WITH MORE than half the total force working in carpenter gangs to keep ahead of spouting plants so well balanced that one of them with a 22-cu. ft. mixer can place 350 yd. in 9 hours, a concrete highway bridge 2300 ft. long, one of the largest in the country, is now being finished at Baltimore. The mud harbor bottom, underlaid with a hard bed of iron ore and gravel, made profitable an unusual order of construction in building the fifteen main river piers. The site of each was dredged and the 65-ft. piles driven and cut off below water before setting the cofferdam. The steel sheet piles not only required no driving, but had to be supported to keep their tops in sight. A concrete seal was placed before the bracing was put in. Water transportation was available for all the material, including the structural steel reinforcement, and was a big factor in the construction layout.

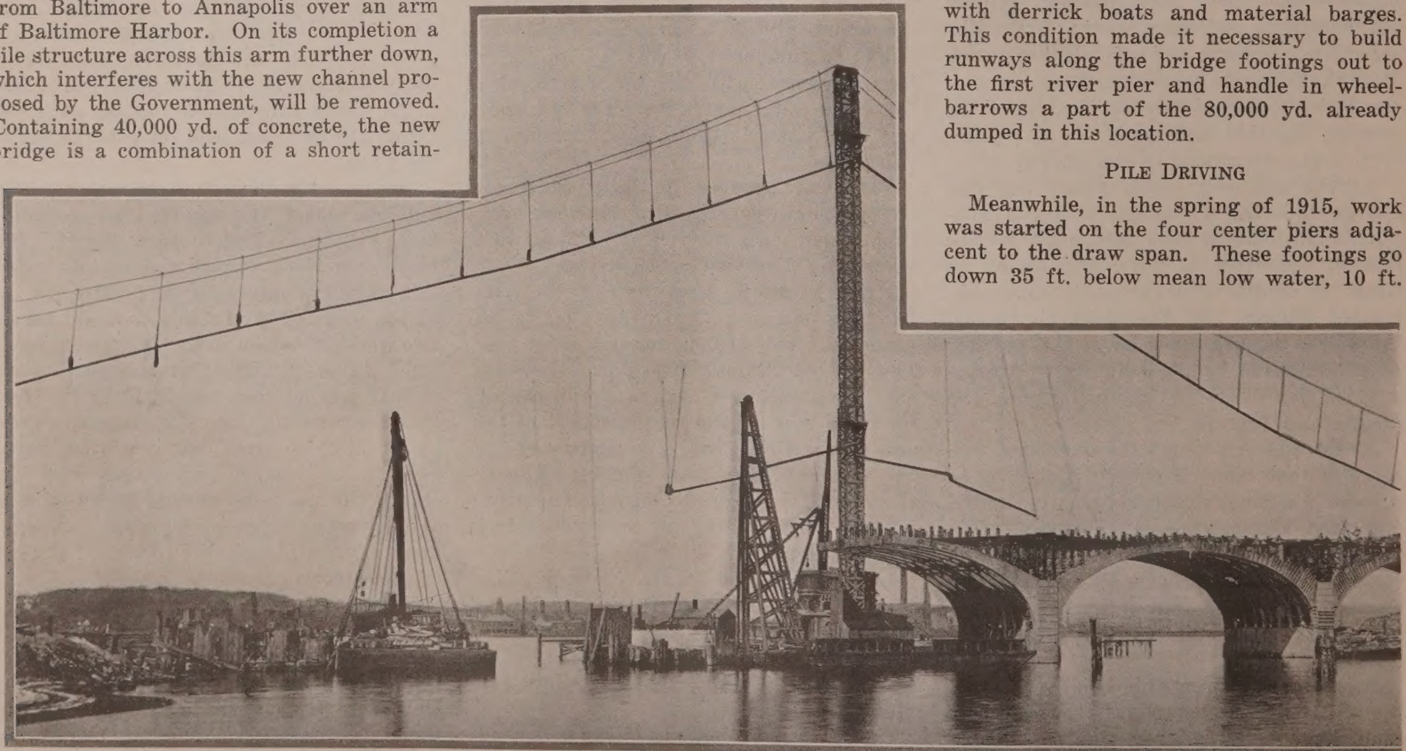
BRIDGE OF UMBRELLA TYPE

The bridge is at the foot of Hanover Street, and will carry the state highway from Baltimore to Annapolis over an arm of Baltimore Harbor. On its completion a pile structure across this arm further down, which interferes with the new channel proposed by the Government, will be removed. Containing 40,000 yd. of concrete, the new bridge is a combination of a short retaining wall approach, a viaduct section, twelve main cantilever spans and a 150-ft. double-leaf bascule draw span. Each pier supports half of each adjoining span on ten ribs, reinforced with structural steel, of which 1685 tons were required. There is an expansion joint in the center of each span. The entire structure, except the south abutment, is supported on 5600 yellow pine piles 40 to 65 ft. long. The south abutment rests on approximately 130 short concrete piles. The bridge will be paved with sheet asphalt and wood blocks and will carry two trolley tracks. In addition to the structural steel reinforcing 800 tons of bar reinforcement were required.

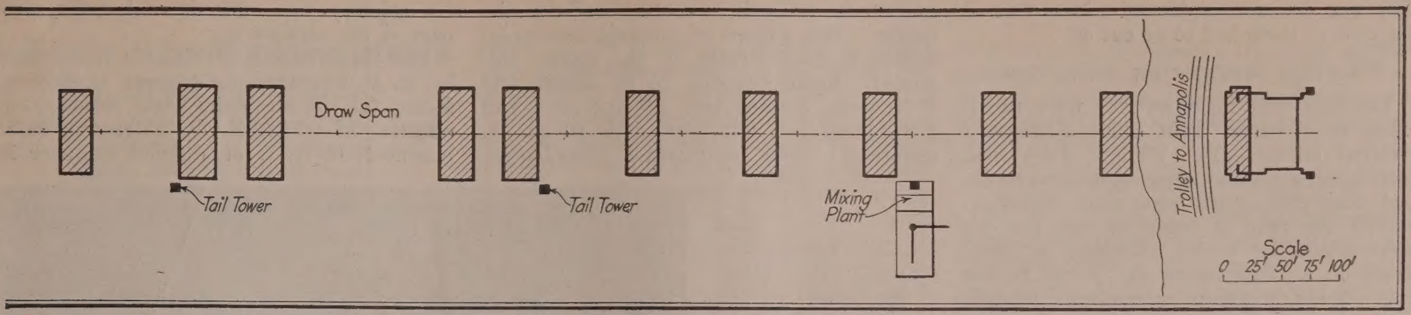
For placing this concrete yardage over a stretch of nearly half a mile a mixer boat was considered, but was estimated to cost, with an additional derrick boat which would be tied up to feed it, more than the tower and chute layout shown in the accompanying illustrations, especially as about 100 ft. of bridge at the south end and about 250 ft. at the north end could not have been reached by mixer boat in any case. With two mixing plants on the main channel, one tower north of them to re-elevate concrete and another mixing plant on the north shore dock, the entire structure was covered. As there was a long delay in securing piles of sufficient length and in determining by means of driving tests how far the hard stratum below the harbor could be penetrated without injuring the piles, the concrete plant on the north shore was the first placed in service. Here the retaining wall approach and 250 ft. of the viaduct were finished in the period from the start of the job, in September, 1914, to May, 1915. At this point work on the viaduct was halted pending the completion of a fill which will be carried out and around the north river pier. Though it was known that the harbor mud would flow out under this fill and require many times the 10,000 yd. that would have been needed if the fill had been on solid ground, it was scarcely expected that the bottom would heave up far out in the bay on both sides of the bridge so that the contractor could not get near the site with derrick boats and material barges. This condition made it necessary to build runways along the bridge footings out to the first river pier and handle in wheelbarrows a part of the 80,000 yd. already dumped in this location.

PILE DRIVING

Meanwhile, in the spring of 1915, work was started on the four center piers adjacent to the draw span. These footings go down 35 ft. below mean low water, 10 ft.



EXCEPT FOR CENTER PIERS BEGUN EARLY TO HASTEN ERECTION OF DRAW, AND SECTION OF VIADUCT WAITING ON COMPLETION



THREE CONCRETE PLANTS AND ONE RELAY TOWER ARRANGED TO COVER STRUCTURE AND UTILIZE WATER DELIVERY OF MATERIALS

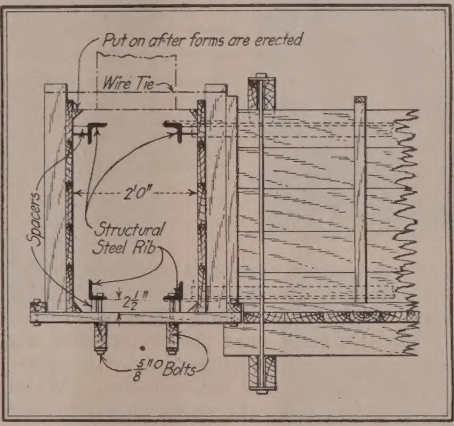
deeper than the other channel piers. They were started first to make the erection of the steel draw possible at an early date. Except for them, the piers were built in regular order from north to south. First the site of each pier was dredged about 4 ft. below grade. The piles were then driven, three floating drivers being used in addition to the two land drivers on the north approach. The outer two rows of piles under each pier are battered. One machine had a pivoted pair of leads with extension leads inside them, while the other two were weighted on one edge of the scow to tip them for driving batter piles. Steam hammers were hardly in order for this work, though one was used throughout the job. The piles went low enough to put the follower on almost at the start, then struck the hard stratum in a few blows, and thereafter could hardly be driven with anything. The engineers arranged with the contractor to drive each pile to much higher resistance than was at first specified, to secure maximum penetration into the hard stratum. Driving in this way, each machine made about twenty-two piles a shift. Driving only to a resistance of 16 tons per pile, one machine put in more than fifty in a shift.

SEAL PLACED BEFORE BRACING

When the piles for a pier were driven one driver, equipped with a circular saw on a vertical shaft supported in the extension leads, cut them off to grade, 22 and 32 ft. below mean low water. The piles were yellow pine, and had to be handled on barges because many of them would not float. It would not do to let the butts fall down in the footing, and each was speared with a long pike pole and pulled to the surface as it was cut off.

The sheeting was next set to an outside template resting on round piles, to which it had to be bolted every few feet to keep it above water. Splined wood sheeting was used for three of the shallow piers and Jones & Laughlin steel sheeting for the rest. This sheeting was pulled for the most part with a single whip by the driver boats, though some of it came so hard as to strip out the pulling holes.

Before the bracing was set in each cofferdam a 2-ft. seal of concrete was placed with double-line bottom dump buckets filled from the tower spouts and handled by one of the three derrick boats. This seal came a foot below the cutoff of the piles. As the piles were driven before setting the sheeting there was no danger of the mud swelling above grade. In fact, gravel had to be used to bring all of the bottoms up to grade before concreting them.



RIB FORMS SUPPORTED FROM STEEL

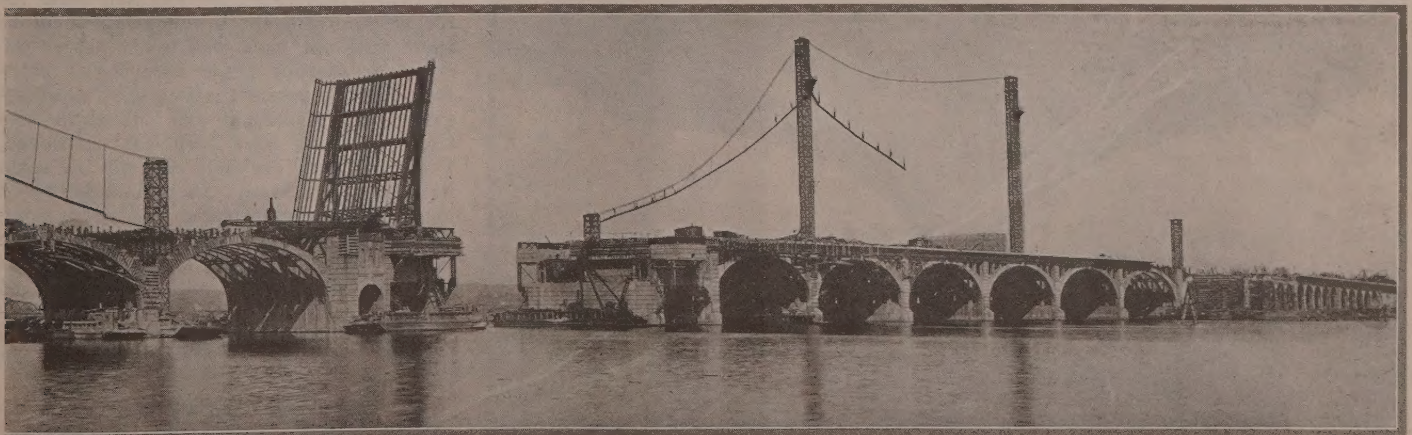
The bracing was then framed a course at a time, sinking of its own weight. It was framed a few inches small. Posts as well as wales and braces were bolted, making a rigid structure. This entire method was made possible because of the accuracy with which the sheeting could be set in the soft mud.

An 8-in. centrifugal pump unwatered most of the dams, though no banking and but a single row of sheeting was used. One, however, in almost 30 ft. of water, required two such pumps and several smaller ones. It was noted in every case that the only difficulty was in getting a start. After the first 2 ft. had been made, the unbalanced head clamped the sheeting against the bracing, reducing slightly its perimeter and jamming all the interlocks tight. After the cofferdams were pumped out a 3-in. pump kept the most of them dry. A sump was dug in the seal and the water pushed to it as the first lift was concreted. The sump was boxed in as the concrete reached it and later filled. After the frustrum of a pyramid, full size at the bottom, which formed the base of each pier shaft, was concreted, the pump suctions were hung outside the forms.

A CARPENTER'S JOB

Even the pier shafts required much form work, as for architectural effect, the portion above water is larger than was actually needed to carry the load. The lower part of the shaft was therefore made for each pier with a longitudinal wall above the base, supported by cross walls. Indeed, to have the draw piers in scale with the bascule leaves, curtain walls were used, hung at the two sides by means of reinforcing rods and supported at the rear by piles. When it came to the superstructure, the bottom chord ribs, the spandrels and the deck had to be formed and poured in three successive operations. It is not surprising, therefore, that of the 250 men employed daily about 135 are in the carpenter gangs. Three full sets of wood forms were provided for every operation at the start of the job. They have required little maintenance.

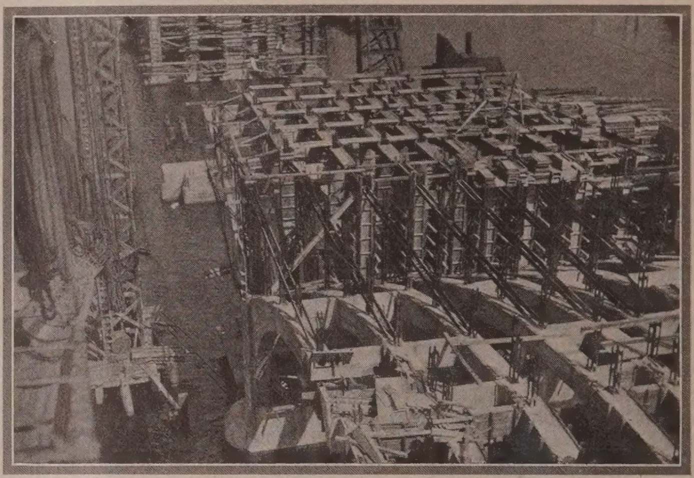
The rib forms are supported entirely on their bottom sections, which are bolted to the flanges of the structural steel ribs. These bolts were screwed out, leaving the nuts embedded. When the bolts were given a quarter turn while the concrete was green,

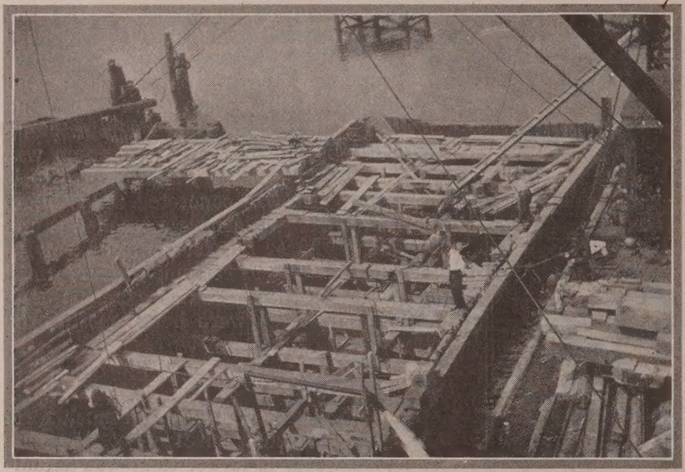


OF FILL, MAIN RIVER STRUCTURE WAS BUILT FROM RIGHT TO LEFT—TOWER AT LEFT MARKS RIGHT MIXING PLANT IN PLAN ABOVE they usually came right out. Less than 5 per cent of them had to be cut off.

NO FIELD RIVETING ON STEEL RIBS

The fact that the steel ribs were fabricated at a water front plant made field riveting unnecessary. Though these ribs, before being tied together with cross struts and concreted, were somewhat flimsy to handle, ten pair of them—enough for one pier—would be loaded standing on their bases on a large barge and towed to the site. A cradle was of course built at each end of the barge to support them. The ribs are tied by heavy rods across the top of a central tower, making each pair a complete unit which could be picked by the top pins in the tower by a derrick boat and set on the anchor bolts on the pier. The cross struts were handled on hand lines. As they were incased in concrete, it was only necessary to bolt them.

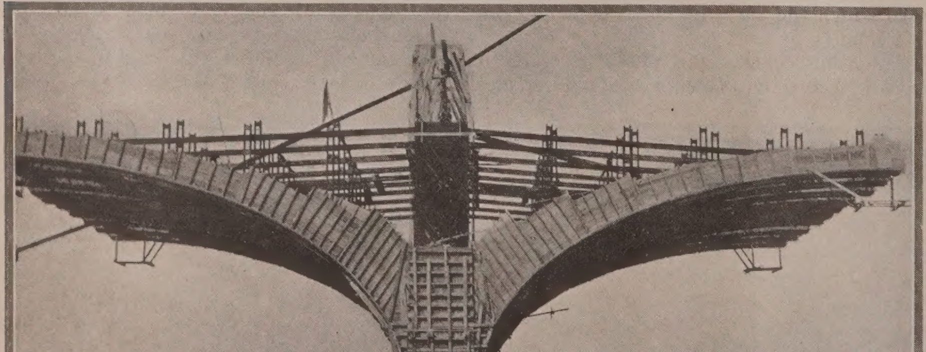

FORMS FOR SUPERSTRUCTURE BUILT AND POURED IN THREE SUCCESSIVE SECTIONS


BRACING BUILT AND SUNK AS UNIT—COFFER FOR PIER NUMBER SEVEN

SPOUTING PLANTS BALANCED

Each tower concrete plant was designed to place concrete at the same speed at which it was made and to supply materials as fast as the mixer could take them. In this way a steady stream of concrete was kept pouring through the chutes, greatly improving its quality and at the same time avoiding all blocking and spilling. Moreover, no part of the plant had to be overloaded, and smooth operation at full capacity was secured. As the mixer was capable of a batch every 40 sec., and as the towers were close to 200 ft. high, a rope speed of 600 ft. per min. was provided for the hoists. This volume of concrete just maintained a good stream in the spouts employed. Small hoppers, 20 ft. square and 8 ft. deep, divided into 1/3 for sand and 2/3 for gravel, were fed with 40 cu. ft. clamshell buckets from barges. The barges made up the storage, as it would have been expensive to build large bins because of the poor foundation available. The mixers, fed by gravity, were near the water level and cement was carried to them from a cement storage boat of 600 bbl. capacity. Water was supplied from the north shore through a 3-in. line laid on the harbor bottom.

The concrete placed left an unusually clean finish against the forms. That in the piers was ready for bush hammering and that in the rest of the structure for rubbing with cement bricks with very little plastering. A manhole in one of the draw piers was filled with fresh water for boiler use by the foreman in charge of erecting the draw span. He stated that this water stood eight days with a subsidence of only 3 in. No attempt was made to waterproof any part of the structure.


FORMS WERE ERECTED, STRIPPED AND MOVED WITH AID OF CARPENTER BARGE

The Hanover Street bridge is being built by H. P. Converse & Company of Boston, Mass., for the Maryland State Roads Commission, of which H. G. Shirley is chief engineer, E. H. Wroe, district engineer in charge of the work and J. E. Greiner consulting engineer. The Raymond Concrete Pile Company was sub-contractor for the piles under the south abutment and the Strobel Steel Construction Company furnished and placed the bascule span.

[*In next week's issue the design of the Hanover Street Bridge at Baltimore will be described.*—EDITOR.]

Pullmans to House Traveling Railroad Gangs

Bessemer & Lake Erie Fits Up Six of These to Replace the Box Cars Ordinarily Used by Bridge Men and the Like

EMULATING the Division of Valuation of the Interstate Commerce Commission in providing quarters for its field men, or perhaps working along independent lines, the Bessemer & Lake Erie Railroad has acquired and is fitting up six old Pullman cars for the use of its traveling bridge gangs, engineers and other groups that can reasonably be depended upon to appreciate and take care of such quarters. Two of these cars have already been put into service, and have to date given complete satisfaction. They replaced the well-known box cars.

The cars are of the twelve-section type, with a single stateroom at one end. They are wooden cars, of course, built in the day of rather elaborate moldings and other interior decorations. In adapting them to their new use, care was taken not to destroy or disrupt these decorations ruthlessly, but to retain them to the fullest degree. The stateroom and the eight sections adjoining have been left untouched. From the remainig four sections the seats have been removed, and replaced by a longitudinal dining table and sofa along one side of the car. These conform to the rest of the woodwork. The smoking room has been converted into a kitchen fitted out with a first-class range and a full complement of cupboards, shelves and kitchen utensils. A Baker heater supplies heat and hot water.

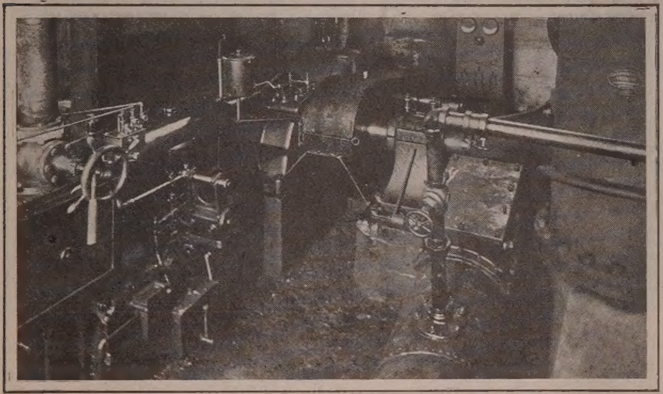
The cars were remodeled under the direction of H. T. Porter, chief engineer of the Bessemer & Lake Erie Railroad.

Electric Drive Replaces Steam for Drainage Pumps

To Realize Maximum Efficiency Two Speeds Are Provided for by New Motors and Chain Belts at Illinois Plant

By E. J. HEGERTY
Of the Westinghouse Electric & Manufacturing Company

BY the substitution of an electric for a steam drive at the pumping plant of the Spring Lake Drainage and Levee District in Tazewell County, Illinois, along the Illinois River, difficulties in obtaining coal, in securing and holding good engineers and operators, and in making emergency repairs —all of which were encountered when the pumping engines were operated on steam—were eliminated. Power from the new motors is transmitted to the old centrifugal pumps by chain belts. By selecting two separate motor sprockets, to be fitted to the shaft as the head against which the pump must work changes, it is possible to operate the pumps at two different speeds, the lower speed being used when the pump is operating against low heads and the higher speed when the lift is near the maximum. For average heads both pumps are operated at a very good efficiency, one on high speed and one on low speed. This arrangement allows the pumps and the motors to operate at high efficiencies at all times.



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MOTOR, STEAM ENGINES AND PUMPS; MOTOR-DRIVEN COMPRESSOR, USED AS VACUUM PUMP FOR PRIMING, WITH ITS STARTING PANEL IN THE BACKGROUND

PUMPING LOAD NOT CONSTANT

The lands comprising the drainage districts of the Illinois and Mississippi rivers are considerably below the levels of the streams the greater part of the year. Hence the only practicable method of bringing these lands under cultivation was to construct a levee system, dig ditches and canals, and install a pumping plant to remove the water to a level that would permit the land to be farmed. Most of the pumping stations in use in this district are steam-driven, the engines being either belted or directly connected to centrifugal pumps. Usually these stations have two pumps, the relative capacities of which are one-third and two-thirds the rating of the station. This difference in size is advisable because heavy pumping is required for only about three months of the year, as from 65 to 75 per cent of the total yearly work of the station is done from March 15 to June 15, while the remaining work is distributed about evenly through the other nine months of the year.

There have been two systems in use to operate these plants most economically. The first, allowing the water to back up in the ditches, starting the pumps only when a sufficient amount has been stored up to justify running the plant, and the second, operating the pumps on alternate days and banking the fires between these periods. The objection to the first method is that it is opposed to the principle of the drainage system, for the water should always be kept at about the same level in the main canal, while the second scheme was undesirable in that about half as much coal is required to bank the fire as to actually operate the pumps.

The Spring Lake Drainage and Levee District extends from a point about 5 miles below Peking, Ill., to 3 miles below the Coperas Creek locks. This district, which contains approximately 12,500 acres, is about 18 miles in length, the width varying from ½ to 3 miles, depending on the distance from the river to the bluffs.

ORIGINAL PLANT STEAM-DRIVEN

The pumping station is at the extreme lower end of the district along the river and is about 15 miles from Canton. The original equipment of the plant installed in 1909 consisted of two 48-in. pumps driven by two cross-compound Russell engines, direct-connected and operating at speeds of from 170 to 215 r.p.m., and one 24-in. pump direct-connected to a single cylinder Russell engine, driven at 250 r.p.m. The pumps were primed by means of steam ejectors, and current for lighting the station was furnished by a small vertical engine direct-connected to a direct-current generator. The boiler plant consisted of two 300-hp. water-tube boilers with hand-fired grates, the necessary draft being obtained from a steam-driven induced draft outfit.

In 1914 the commissioners of the district advertised for electric motors with controllers and chain drive for operating the pumps. Some of the main reasons given for changing from steam to electric drive were the difficulty in obtaining coal, in securing and holding good engineers and operators, and in making repairs in case of emergency. In addition, the foundations of the engines and pumps were on poor soil and weak piling, so that it was impossible to maintain the proper alignment of engines and pumps, which resulted in a high maintenance cost. The contract for the work was awarded to Hoppin & Rich, engineers, of Peoria, Ill., who made a thorough investigation of the proposed change and the method of making alterations necessary for the Canton Gas & Electric Company in supplying the current.

13,000-VOLT TRANSMISSION LINE

Energy is supplied over a three-phase, sixty-cycle, 13,000-volt transmission line. The substation at the pumping plant consists of four 25-ft. poles placed one on each corner of a concrete foundation 5 ft. wide and 15 ft. long. On these are mounted the lightning arresters, disconnecting switches, choke coils and fuses. The transformers, which are each 200 kva, 13,000 to 460 volts, are mounted on the concrete base. There is no building or roof over this substation, a picket fence inclosing the whole apparatus.

ELECTRICAL EQUIPMENT

The electrical equipment of the pumping plant consists of two 300-hp. and one 100-hp. Westinghouse 440-volt induction motors, with starting equipment consisting of auto transformers and switchboard type oil circuit-breakers. The larger motors are connected to the 48-in. pumps by two 25-in. silent chain belts, and the 24-in. pump is driven by a 10-in. chain belt. The sprockets on the pump shafts were placed in the position occupied by the flywheel and eccentrics when the plant was steam driven.

The purchaser's specifications required the pumps to be operated at two speeds, as explained in the first paragraph. A compressor, used as a vacuum pump, replaces the steam jets which were used for priming the pumps when the steam plant was in use. The installation of the motors and changes in piping to allow for the new priming and water level maintaining system was made without interfering with the operation of the steam plant. The cost of making the change was small, and as no structural changes were made in the plant to accommodate the electric drive, the present steam plant is intact and can be put into service in a very short time at small expense.

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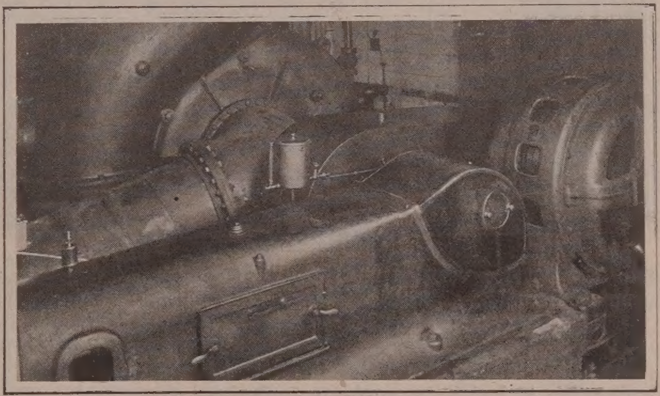
METHOD BY WHICH MOTOR AND PUMP ARE CONNECTED — MOTOR USED REGULARLY BUT ENGINE READY FOR EMERGENCY SERVICE



The station does not operate continuously at its full capacity, nor does it operate every day. The pumping depends largely on the season of the year and the amount of rainfall. The usual load on the plant is about 250 kw., and during a part of the year this load is on the lines about 10 or 12 hours per day, but none of the motors is operated during the period of the day in which the company carries its peak load. During the heavy pumping season the motors are sometimes operated 18 to 24 hours per day, and in extremely wet periods all of the pumps taking practically 600 kw. have been operated for a few hours at a time.

The cost of operation has compared very

SECTION 1

Applying to districts draining not more than 2500 acres

	Per kw.-hr.
First kw.-hr. per acre per month of total acreage drained	$0.045
Second kw.-hr. per acre per month of total acreage drained	.036
Third kw.-hr. per acre per month of total acreage drained	.028
Remaining kw.-hr. per acre per month of total acreage drained	.022

SECTION 2

Applying to districts draining more than 2500 acres, but less than 7500 acres

	Per kw.-hr.
First kw.-hr. per acre per month of total acreage drained	$0.04
Second kw.-hr. per acre per month of total acreage drained	.03
Third kw.-hr. per acre per month of total acreage drained	.025
Remaining kw.-hr. per acre per month of total acreage drained	.02

SECTION 3

Applying to districts draining more than 7500 acres

	Per kw.-hr.
First kw.-hr. per acre per month of total acreage drained	$0.03
Second kw.-hr. per acre per month of total acreage drained	.0225
Remaining kw.-hr. per acre per month of total acreage drained	.015

favorably with steam operation, and the certainty and freedom from interruption have made the service very satisfactory to the commissioners.

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CHECK DAMS WERE CONSTRUCTED WHICH SUCCESSFULLY WITHSTOOD THE IMPACT OF THESE GREAT ARTIFICIAL FLOOD FLOWS

POWER RATES

The schedule of power rates in effect in Canton, Ill., and vicinity, applying to drainage and pumping, was devised by the firm of Hoppin & Rich after a study of the existing rates and the cost of power at the company's switchboard. The power is sold at a certain rate per kilowatt-hour per acre per month, the rate depending on the amount of land served and the amount of power used.

The rates devised by the engineers of the Canton Electric Company are shown in the accompanying table.

A cash discount of 5 per cent and an off-peak discount of 5 per cent are allowed from above rates. The minimum charge is $10 to $20 per horsepower per year.

Anthracite Production in Pennsylvania Falls Off Slightly

The production of anthracite coal in Pennsylvania in 1915 was about 2 per cent less than in 1914, according to a bulletin of the U. S. Geological Survey. The figures in gross tons were respectively 79,459,876 and 81,090,631, and the values at the mines were $184,653,498 and $188,181,399, the average value per ton at the mines being practically $2.32 each year.

Small Check Dams, in Series, Lessen Flood Velocities in California Ravines—Part I

Experiments Prove Value of Obstructions in Channels Where Floods Originate—Water Robbed of Debris Carrying Power

By HARRY F. OLMSTED
Of Buck & Olmsted, Conservation Engineers, Los Angeles

WITHIN the mountain areas of Los Angeles County, California, there has been conducted, during the past twelve months, a series of experiments which was instituted to show conclusively the effect of unit obstructions upon stream flow. The flood problem in the United States is such an important one, and engineering methods employed in remedy have proven so futile, that these experiments carried out along lines entirely new to American practice have attracted wide attention. In brief, the experiment has consisted in adapting the Swiss system of flood prevention to ravines and canyons which comprise the upper watersheds of certain torrential streams in southern California. This system consists of placing in the upper channels, where floods originate, many small and inexpensive cross structures or miniature dams, which materially reduce the flood velocities, rob the waters of their debris carrying power, and make for greatly increased absorption in the gravels.

CHARACTER OF STREAMS

The streams of Los Angeles County are not rivers, or even brooks, in the dry season, at which time the major portions of their great lower channels are devoid of surface flow. The largest stream in the county, the San Gabriel River, which drains a mountain area of 222 sq. mi., has had a minimum flow of 2 sec.-ft. at its mouth as against a maximum flow of 45,000 sec.-ft. The rainfall that is largely responsible for these changes falls between Nov. 1 and May 31, and the flood producing precipitation may be expected in the months of January, February and March.

The only other large stream in the county is the Los Angeles River, which, during floods in past years, has had a runoff of at least 40,000 sec.-ft., and perhaps more.

The significant characteristic of these immense flood flows discharging from watersheds whose minimum flows are so small, is the great amount of debris, sand and silt which they carry from the upper reaches of the streams to the valleys below. The comparatively short distance from the mountain crest line to the sea, 40 miles, and the pronounced drop, 6000 ft., with a constantly diminishing gradient, causes flood waters to transport great masses of detritus from the upper reaches and to deposit them in the lower channels. This building up process has caused a greater and greater area to be menaced and has resulted in the failure of every lower channel in southern California to carry the floods, excepting that of the Los Angeles River through the city of Los Angeles. Major floods occur in southern California on an average of every seven years, although there have been periods of as high as 29 years between these visitations. During the flood of 1914 Los Angeles County experienced a financial loss of over $10,000,000. This was undoubtedly the greatest loss by flood in the history of the county, for, although the flood was by no means the most severe, the improvements menaced and wrecked were the greatest of any flood year. Future floods of equal violence will cause without question even greater losses.

DAM AT EXPERIMENT STATION EQUIPPED FOR INSTANT RELEASE OF 1000 SECOND-FEET OF WATER

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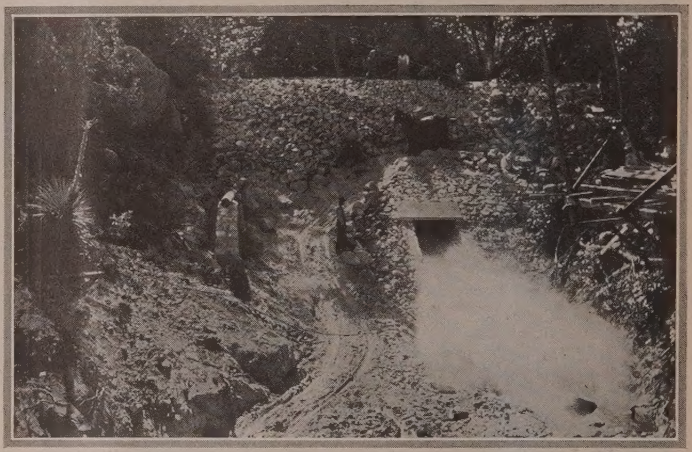


BOARD INVESTIGATES FLOOD PROBLEM

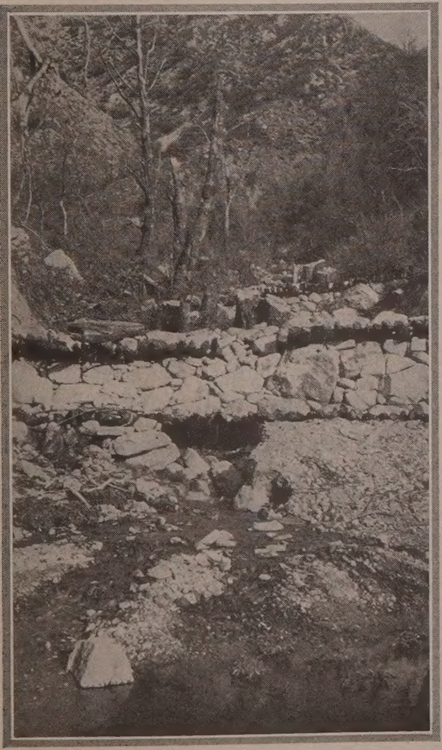
The board of engineers for flood control, appointed by the Los Angeles County supervisors in April, 1914, reported over one year later that a fund of $16,500,000 would be required to carry out measures for flood protection, which could be depended upon to relieve the situation in Los Angeles County. There was some diversity of opinion among the engineers constituting the board as to the relative importance of certain types of work recommended in the report. For instance, it was recommended by the committee on conservation that $4,130,838 be appropriated to provide for impeding dams in the mountain ravines, rock-fill dams in the canyons, masonry dams where reservoir sites exist, spreading devices whereby the canyon waters could be made to cover debris cones to obtain the maximum absorption, and for the reforestation of denuded areas. The sum included in the $16,500,000 total to provide for these measures was only $2,800,000. The difference was occasioned because the majority of the board believed that the restraining dam method had not been sufficiently tested in America. This belief, together with the fact that there was no way to ascertain mathematically what degree of efficiency this class of construction might attain, influenced the board in recommending the smaller sum.

The committee recommending the large appropriation took this position:

1. Any comprehensive flood control plan for Los Angeles County must not alone provide for a quick and safe delivery of flood waters into the sea, but must also look to the reduction of these wastes by utilizing all surface storage sites.
2. Any engineering means that would check the velocities of flood water in the mountain region and thus prevent the great disgorging of debris into the lower channels and upon the lower lands, should certainly be adopted, providing the cost was not prohibitive.
3. The great cones of gravel deposits at the canyon mouths should be utilized to the greatest possible extent as absorption grounds for the clarified flood flows.
4. The cost and character of the lower channel rectification must necessarily be influenced by the diminution of flood crests by means of the upper work.

CHECK DAMS PROPOSED

That there is some relief to be afforded from the retarding works in the mountain regions no one will deny. It is also an indisputable fact that there will always be need for lower channels. The proportion of any given appropriation that should be devoted to each, and the order in which the expenditures should be made, were, therefore, the questions confronting the board of engineers.



A LITTLE THE WORSE FOR WEAR—AN APRON OR SPILLBREAK SAVED THIS STRUCTURE. ANNUAL MAINTENANCE WILL BE SMALL BUT ABSOLUTELY ESSENTIAL IN THE CORRECTED CANYON

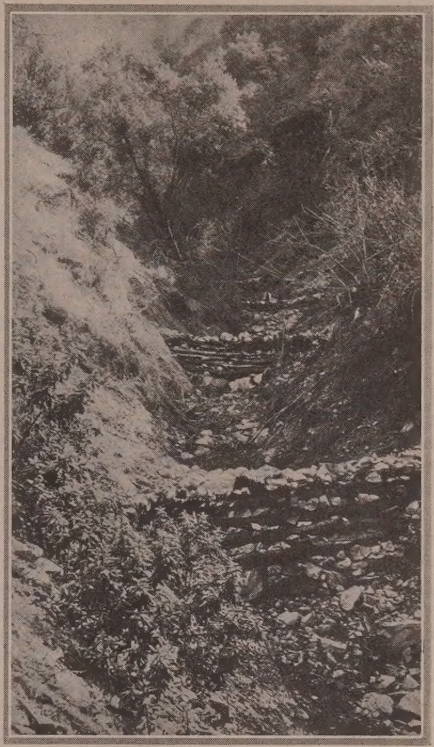
Frank H. Olmsted, the writer's father, the chairman of that committee of the board which investigated the subject of water conservation in its relation to flood crests, was responsible for the introduction to the board of engineers of the idea of the check dam method. He argued that, without the mountain control, channel expenditures in the lower reaches would be wasted in the future as they have proved to be in the past and that until such mountain works were constructed it would be impossible for any one to approximate with any degree of accuracy the amount of relief to be afforded by this system.

Reports concerning the control of certain Swiss and Austrian rivers by means of check dams, forestry, etc., stated that for many years no real success had attended the efforts of foreign engineers to control the torrents in the Rhine Valley by means of channel work in the lower rivers. Channel rectification, bank protection, and levee work were all recognized failures until the erosion in the upper reaches had been prevented by the check dam system and by the terracing and planting of barren and badly eroded slopes.

Mr. Olmsted became convinced that the Swiss system could be admirably adapted to the Southern California mountain region, where it would be a powerful factor in the reduction of flood flows by conservation. He pointed out that while the European engineers had a much more adaptable material in slate with which to build their retarding structures, the granite formation of the Southern California mountains afforded fair building material and an added advantage in the highly porous character of the mountain slopes, the lower channel bottoms, and the debris cones.

$23,000 FOR EXPERIMENTS

At the earnest solicitation of Mr. Olmsted, the board of supervisors acquiesced in the expenditure of $23,000 for experimental work to test out the Swiss system. About $13,000 of this amount was expended on an experiment station in Clear Creek, a small tributary of Tujunga River. This experiment station consisted in the first instance of a rock fill dam with masonry core. This dam was made 24 ft. high and was equipped with collapsible gates which would instantly release 1000 sec.-ft. when the reservoir was filled. The canyon was a short one, well brushed, very crooked in alignment, and somewhat typical of the flood producing ravines of Los Angeles County. Observations were taken at various points below the dam, when as much as 700 sec.-ft. were instantly released. This caused a great wave of water to rush down the canyon. There were several experiments of this nature taken to note the initial velocity of flow and its observed retardation, both in the clear channel and after the structures were installed. Check dams were built in the streamway in two sets of ten each, and observations of flow were taken at the completion of each set.



THESE STRUCTURES ARE OF DRY RUBBLE MASONRY AND IMPOUND LITTLE OR NO WATER BEHIND THEM. EACH DAM ACTS AS A PROTECTOR FOR THE ONE BELOW IT. THUS IT IS ESSENTIAL THAT THE UPPER REACHES BE TREATED FIRST

From these experiments certain types of structures required to withstand the sudden impact of varying quantities of water have been evolved, and quantitative values for the retarding effects of natural obstructions and the unit structures have been determined. In brief, the results of this portion of the experiments furnished convincing evidence that this system could be applied at a reasonable cost to the Southern California ravines with beneficial results, and that the structures themselves were stable under flows approximating cloudburst conditions. For example, when 210,000 gal. of water was instantaneously released, the initial velocity measured 19.5 ft. per second. In the clear and unobstructed channel 1100 ft. distant, the natural velocity had dropped to 7.8 ft. per second. This same amount of water instantly released over the same reach with ten cross structures installed, showed a velocity of 4.8 ft. per second at the lower station, or a 38.5 per cent velocity reduction. In other words, these ten check dams

DATA ON DISCHARGE AND VELOCITY AS AFFECTED BY CHECK DAMS, CLEAR CREEK EXPERIMENT STATION·

Head, ft.	Storage, gal.	Disc., cu. ft. per sec.	Initial vel., ft. per sec.	Vel. at 1100 ft. clear channel	Vel. at 1100 ft., 10 dams, av. ht. 4.22 ft.	Vel. at 1100 ft., 20 dams, av. ht. 3.95 ft.	Reduction of debris-carrying power at 1100 ft., 10 dams, per cent	Reduction of debris-carrying power at 1100 ft., 20 dams, per cent.
11	210,000	700	19.5	7.8	4.8	2.9	95	99.6
9	112,500	468	15.0	5.6	3.2	1.6	96.5	99.8

had reduced the transporting power of this flood flow 94.5 per cent in 1100 ft. The same quantity of water released over the same reach with twenty cross structures showed a velocity of 2.9 ft. per second at the lower station, or 63 per cent of velocity reduction with a corresponding reduction of 99.6 per cent in the transporting power.

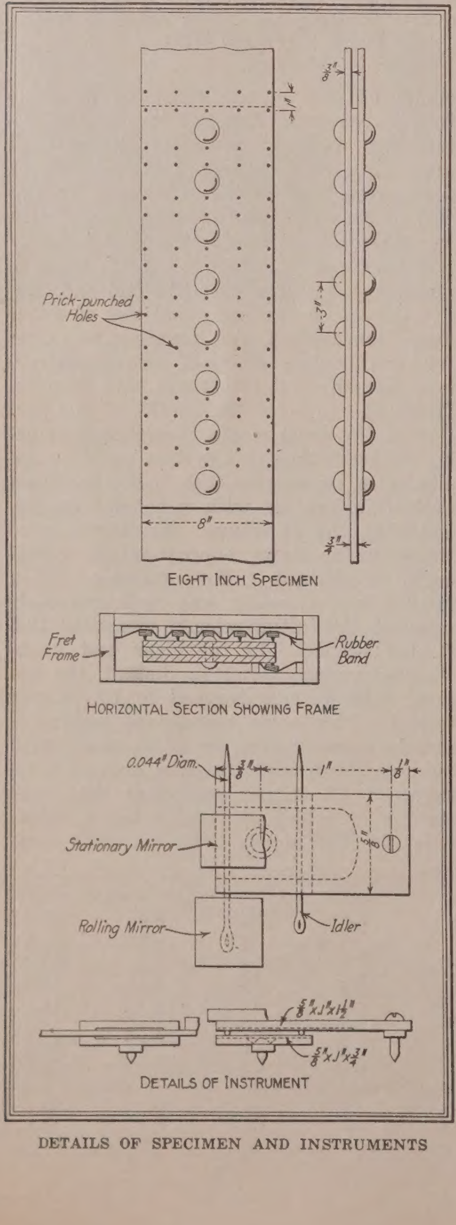
With 112,500 gal. storage, which would probably more nearly represent the maximum flow of a cloudburst in this canyon, the showing was even better, as indicated by the accompanying table.

(To be concluded)

Riveted Joints Being Tested by Series of Simple and Accurate Mirror Extensometers

New Method of Applying Strain Apparatus to the Determination of Rivet Slip and the Distribution of Stress in Riveted Joints Explained

SEVERAL ASSUMPTIONS almost universally made in the design of riveted joints have never been fully justified by extensive and exact scientific tests. For example, it is assumed in the design of a typical joint that the given total stress in the main members is distributed equally among all the rivets in that member, and that the unit stresses in the rivets shall be based upon shear or bearing values obtained by tests for ultimate strength, regardless of the effects of rivet slip and of the initial rivet stresses, shrinkage and frictional grip. Tests are being made at Purdue University by the use of a new device consisting of a series of mirror extensometers distributed along the test piece between the rivets, and designed to make possible the accurate determination of (a) the unit stress on the rivets at which the first slip occurs; (b) how the total stress is proportioned among the various rivets in a connection, and (c) how this distribution of stress is affected by the proportions and areas of the connected pieces.



DETAILS OF SPECIMEN AND INSTRUMENTS

These tests will supplement those already made and reported by the American Railway Engineering Association in March, 1905, and by the University of Illinois in Bulletin 49, which indicate small slips at low unit stresses. While the results of the present series are not yet available, the general method being used and the details of the instruments have been furnished by Albert Smith, professor of structural engineering at Purdue University.

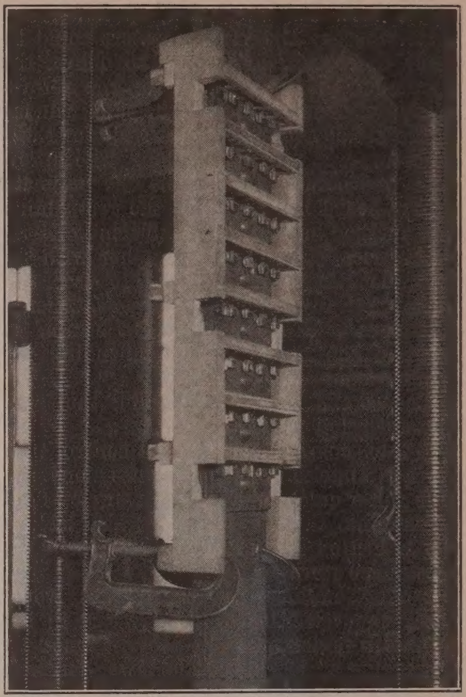
The accompanying diagrams indicate the manner of constructing the mirror extensometers and the supporting frame and applying them to an 8-in. specimen with a single row of eight rivets. For this case the instrument consists of a series of rows of small mirror extensometers, five in each row, which indicate the strains in 1 in. for these rows between the rivets, as shown.

These small extensometers are constructed of two plates supported by pins in prick-punched holes in the specimen. Two small steel rollers, or needles, to one of which a thin plate-glass mirror is attached by plaster of paris, separate these plates, as shown in the diagram, and each plate is ground so as to leave a narrow track on the edges in contact with the rollers. The rows of instruments are held in place by a wooden frame and a rubber band stretched across frets. The tension of this band holds the instrument points firmly in the prick-punched holes on the specimen and keeps the rollers in position between the two plates. A fixed mirror attached to the outside of the longer plate is designed to give corrections to be applied to the readings of the roller mirrors to eliminate errors from bending or vertical displacement of the specimen.

At a convenient distance from the specimen a telescope is set up, which looks in the mirror and back into a vertical scale at the desired distance from the mirror. It has been found desirable to make the line of sight as nearly horizontal as possible, and this involves cutting a hole in the scale to receive the barrel of the telescope.

MAKING OBSERVATIONS

When the specimen is subjected to tension the deformation causes the distance between the prick-punched holes to increase, and results in a relative motion of the two plates equal to the unit deformation, since the holes are 1 in. apart. The needles revolve through a vertical angle α (equal to the deformation divided by the diameter of the needle), causing the line of sight between the mirror and scale to move through the vertical angle 2α. For a scale distance of 100 in. the reading thus equals 200α. It has been found possible to read hundredths of an inch at this distance with a probable error of one hundredth. The smallest stress which can be observed is thus about 60 lb. per square inch.



FRAME ATTACHED TO SPECIMEN

DETERMINING SLIP POINTS

The row of instruments above the first rivet of the joint should show the fiber stress due to the total load. The instrument between the first and second rivet should show a fiber stress diminished by the stress carried by the rivet to the middle plate. So long as the difference between the readings of the first and second rows of instruments is large and constant, the first rivet is carrying its proper load. When for a 1000-lb. increment this difference disappears or becomes negative, the first rivet has slipped. Then as the stress is increased the increments of the second row of instruments again increases until the first rivet slips again. Similar observations show the point at which the second rivet slips.

The average fiber stress across any section multiplied by the area gives the stress at that section, and this stress subtracted from a stress similarly obtained for the section above gives the stress carried by the rivet between.

In the last test made upon a four-rivet specimen, after the load had been carried up to the design load for $\frac{3}{4}$-in. rivets, the load was dropped to 20,000 lb. and then brought up to 25,000 lb., and the mirrors were read. Twice again the load was dropped and raised, and readings were taken. Each mirror thus had three return readings, and for thirty-one of the thirty-two instruments the check was remarkably good, being within 0.01 in. on the scale for a total movement of 0.80 in. One reading for one instrument showed a large difference, probably due to an error, as the others agreed.

This work is being conducted in the testing laboratory of Purdue University, of which W. K. Hatt is director, by Prof. Albert Smith and H. H. Schofield.

Is the Ton-Mile the Proper Basis for Allocating Railroad Operating Costs?

Are Not Maximum Loads More Pertinent Than Total Tonnages, and Should Not More Weight Be Given to Deterioration Independent of Traffic?

By PAUL M. LA BACH
Assistant Engineer, Chicago, Rock Island & Pacific Railway, Chicago, Ill.

IS EITHER the ton-mile or the train-mile the proper basis for allocating railroad operating costs between passenger and freight service? Are not maximum loads and stresses, for which railroad structures are designed, more pertinent than total tonnages, and should not more weight also be given to the fact that a large percentage of deterioration is independent of traffic?

The Interstate Commerce Commission and various state commissions having decided that freight and passenger business must each be self-supporting, it has been the duty of various judicial and administrative bodies to find out how this shall be brought about. Up to the present no two of these bodies have agreed, which is not at all surprising when we consider the fact that the hypothesis from which a start is made has little to support it. This assumption is that present accounting systems can be utilized for the purpose.

PRESENT ACCOUNTING SYSTEM

It is a primary principle in cost accounting that the different items must be charged out at the point of origin. Little can be expected from a system which attempts to do this backwards by subdividing the sum total into its constituent elements. This applies particularly to the items which are simply collective. If a factory should charge out all items for axles, for instance, without reference to the kind, little would be known about the cost of any particular one. In addition to this the requirement that a subdivision must be made for freight and passenger costs means that the origin of each cost must be ascertained. This adds a complication which has no very satisfactory solution particularly with reference to maintenance of way and structures.

In a good deal of the discussion of the subject there seems to be a tendency for the proponents of one method or another to describe other methods as "too theoretical." All are practically in the same boat insofar as theory is concerned, but some theories are apparently simpler than others. Recourse must be had in all these discussions to published authentic accounts, and for that purpose the Interstate Commerce Commission published statistics are the only ones now available for comparative purposes. They subdivide the maintenance of way and structures accounts as follows: (1) superintendence; (2) ballast; (3) ties; (4) rails; (5) other track material; (6) roadway and track; (7) removal of snow, sand and ice; (8) tunnels; (9) bridges, trestles and culverts; (10) over and under crossings; (11) grade crossings, fences, cattle guards and signs; (12) snow and sand fences and snowsheds; (13) signals and interlocking plants; (14) telegraph and telephone lines; (15) electric power transmission lines; (16) buildings, fixtures and grounds; (17) docks and wharves; (18) roadway, tools and supplies; (19) injuries to persons; (20) stationery and printing; (21) other expenses; (22) maintenance joint tracks, etc., Dr.; (23) maintenance joint tracks, etc., Cr.

It will be seen that these are collective accounts without reference to cause of expense except in one or two instances. Broadly speaking, all necessary expense is due to one of three causes: (a) Legal or community requirements; (b) destructive forces of nature; (c) destructive mechanical forces originating in the conduct of transportation.

Under the heading (a) are a large number of items not found in the classification above. Some may be partly included in (1), but others are found by name, such as fencing, cattleguards, signs, under and overgrade crossings. They have nothing to do, as a rule, with the relative amounts of the different kinds of traffic, as they are primarily intended to protect abutting property owners, pedestrians, etc. Undergrade crossings might be considered to have some relation to the differences in traffic, but that relation is very slight.

Under the heading (b) is included what is sometimes called weather stress. Erosion, decay, oxidation or similar manifestations may destroy or decrease the efficiency of the track structure. It is used here in the sense of destruction which would take place if no trains were run. The process is hardly perceptible at times, but the maintenance of a railroad constantly calls for the flushing of embankments, digging of ditches, repairing of snow fences, cleaning of culverts, replacing of bridges and embankments after washouts. Also, rails rust and ties decay, but we take little note of it. A great deal of track work, such as surfacing, is due partly to the presence of water and not altogether to the movement of trains. Two years ago $10,000,000 was lost through floods in one state, and it is not unusual for a large system to lose $1,000,000 in a season through floods.

Under the heading (c) we have the element which has been most discussed and frequently used as the criterion for the division of all expenses. That the movement of trains does cause destruction goes without saying, but it frequently causes less than half the annual maintenance expense.

The foregoing only includes *necessary* expenses. Anything not utilitarian is assumed to be omitted. However, business is not done that way, and lines having extensive passenger traffic indulge in ornamentation, landscape gardening and various other expenses to please the eye of the traveling public. This has been called a prosperity factor and should be chargeable to passenger expense, as it makes little difference to the freight service if things do not look spick and span.

EQUATION FOR MAINTENANCE EXPENSES

The equation for total maintenance of way and structures operating expense will then be

$$A + B + C + D + fx + py = Q$$

where A = amount (buildings, yards, etc.) which can be charged to either freight or passenger traffic by reason of exclusive occupancy or usage; B, a prosperity factor which causes a prosperous railroad to indulge in landscape gardening and other methods of pleasing the eye of passengers; C, legal requirements for the safety of persons or property of neighbors (the cost usually varies with the density of population; the items are fences, cattleguards, signs, grade crossings, etc.); D, amount necessary to overcome the destructive effects of erosion, corrosion, snow, ice and floods; f, amount needed to overcome the destructive effect of a unit of freight traffic; x, total number of units of freight traffic per year; p, amount needed to overcome the destructive effect of a unit of passenger traffic; y, total number of units of passenger traffic per year, and Q, total expenditure.

TABLE 1—ITEMS FOR A CERTAIN RAILROAD THAT DO NOT ORIGINATE IN MECHANICAL WEAR OF TRACK USED JOINTLY BY BOTH FREIGHT AND PASSENGER EQUIPMENT

A ($36 passenger; $64 freight)		$100
B		0
C		25
D		
Rail—cost $6,000 (90-lb); length of life, 50 years	$120	
Ties—creosoted—cost $3,200; length of life, 20 years	160	
Ballast—cost, $5,600; length of life, 20 years	180	
Ditching and restoring cross-section	100	
Widening banks to original cross-section	75	
Replacements due to floods, washouts, cleaning culverts	100	
Cutting grass and weeds	25	
Removal of snow and ice	30	
		$790
Total K		$915

For the sake of brevity, $A + B + C + D$ may be represented by K, which thus represents all those items which do not originate in the mechanical wear of track used jointly by both freight and passenger equipment. The formula thus becomes:

$$K + fx + py = Q$$

Table 1 is an estimate of the value of K on a railroad in the Mississippi valley. The unit is one mile of main track.

The foregoing, of course, has no general application, but the road in question averaged about $1,400 per track mile for total maintenance of way and structures, the item $fx + py$ being only $485, or about 34 per cent of the total. A, B, and C can

TABLE 2—MAINTENANCE COSTS PER 1000 CAR-MILES OF RAILROADS WITH VARIOUS RATIOS OF PASSENGER AND FREIGHT TRACKS

Railroad	Miles of main track	Cost of maintenance of way and structures per mile of main track	Passenger-car mileage being 1.00 freight-car-mls. are as below	Maintenance cost per 1000 car-miles per mile of track	$K - A$ assumed as $800 per track-mile	Cost of maintenance per 1000-car-miles per track-mile for $fx + py$
Long Island	602	$2,028	0.39	$35.20	$800	$21.5
Atlantic City	248	1,638	0.62	41.43	800	21.2
West Jersey & Seashore	526	1,639	0.69	38.11	800	19.5
New York, New Haven & Hartford	3121	2,414	2.64	25.50	800	17.1
Philadelphia, Baltimore & Washington	1083	2,680	2.96	20.83	800	13.1
Boston & Maine	2903	1,945	3.94	19.45	800	11.4
Delaware, Lackawanna & Western	1595	2,849	6.17	15.04	800	10.8
Pennsylvania	6504	3,117	7.43	14.29	800	10.6
Northern Central	679	2,194	7.88	13.77	800	8.7
Philadelphia & Reading	759	2,646	10.32	13.34	800	8.3
Lehigh Valley	2183	1,813	13.63	11.07	800	6.2
Norfolk & Western	2531	1,879	20.20	9.15	800	5.2
Virginian	508	1,573	24.45	10.96	800	5.4

usually be ascertained wih little difficulty by the usual appraisal methods.

How Subdivide $fx + py$

The sum $fx+py$ may fluctuate from 20 to 60 per cent of the total, depending on the density of traffic, but even in extreme cases there does not seem to be good reason for attempting to allocate all expenses by the use of a traffic unit. How then shall $fx + py$ be subdivided?

The most logical method is by comparing the stresses produced by each style of locomotive when running at its maximum allowable speed. These stresses have been measured in the rail by use of the stremmatograph. A thousand pounds static load will be 1250 lb. for a Mikado at 35 miles per hour and 1390 lb. for an Atlantic type at 60 miles per hour if the effect on stresses is condensed. This is an increase of 11 per cent for the passenger. The ton-miles of the passenger locomotive (minus tender) multiplied by 1.11 would form a ratio with the locomotive ton-miles of the freight locomotive multiplied by 1.00. In the foregoing case the division of $fx + py$ would be $230 for freight and $255 for passenger.

A railroad track, like other structures, is designed to carry its maximum loads. Average loads have little bearing on the first cost. The same is true to a certain extent of maintenance. The greatest damage is done by those loads which create stresses near the elastic limits of the material employed. Loads which are well within these limits may be repeated many millions of times without any apparent effect. As the stresses created by the high-speed locomotives are very near the elastic limit of steel it would seem only fair to use these locomotives as a criterion rather than a traffic unit which may have little bearing on the history of the subject.

Reverting again to the problem, we have from *A*, Table 1, $64 for freight and $36 for passenger. These, added to their respective values of $fx + py$ ($230 and $255), give us, as final figures, $294 per mile for freight, $291 per mile for passenger and $815 which is not affected by the question, as it would not increase or decrease if all trains were passenger or all freight, unless it was found in the latter case, as would undoubtedly be true, that a less expensive track could be used.

Expenses Not Affected By Traffic

How this $815 should be divided would be a good subject for argumentation. In an ordinary business it would probably be divided in the ratio of the net profits of the two classes of business. The calculations, however, are used in rate cases in which the profit is necessarily a point of issue, and so some other method will have to be selected. As railroads generally are required to perform two distinct classes of service without reference to the profitableness of either, it would appear to be equitable to divide all these expenses, which do not originate in the class of service, into two equal parts. In the above case, if the amount was divided equally, $815 would be charged out as $407 freight and $408 passenger. These figures added to $294 and $291 give us as the final answer, freight, $701, and passenger, $699.

The published statistics unfortunately do not have a common unit of weight for freight and passenger equipment which can be used in statistical arguments. For that reason the car-mile, as it is the smallest common unit, may be used. No claim is made from an engineering point of view that the effect of a freight car and a passenger car are the same. The fact that passenger traffic cannot be compared with freight traffic on either a ton-mile or a train-mile basis can, however, be shown by this unit.

Figures For Various Railroads

The roads in Table 2 have, with the exception of two, been money makers for a long term of years and have little deferred maintenance. The table shows that when the number of passenger-car-miles exceeds the number of freight-car-miles the cost per mile of main track increases for the 1000 car-miles per mile of track. The hypothetical problem which has been worked out would probably not apply except on granger roads having a car-mile ratio of about 4.5:1.

In this Table 2 accounts 15, 16 and 17 have been subtracted from total maintenance of way and structures. It will be noted that after taking them out and then subtracting a constant of $800 per track-mile that the roads doing the greater passenger business still have the greater unit costs. This does not bear out the contention that the two classes of business are comparable on a ton-mile basis. It is probable, however, that the constant is too small in some cases, as a survey or actual experience in the engineering department of each road would be needed to get it accurately. The roads at the head of the list also run trains faster than the 60 miles per hour assumed at the beginning.

The writer makes no claim for anything in the foregoing except the method of analysis. That some similar method must be used in rate cases in order to obtain correct results seems obvious. The revision downward of first freight and then passenger rates without reference to each other or to the business as a whole is apt to result in the omission of items which are common to both, and thus deny the railroad a fair return on the investment.

Discharge Into Draft Tube Increases Power Output

That the water conducted by sluices from a pond upstream during the flood season at the Barton plant of the Eastern Michigan Edison Company, and discharged into the draft tube, increases the power output of the turbines and compensates in a large measure for the decreased output due to the rise of the tail-water level has been proved by actual tests.

During the construction of the plant the sluices were used to carry the low-water flow of the river, and in the completed structure have been used for lowering the pond. During the flood season they are used to assist in regulating the pond level, with the result that the water discharged into the draft tube effects an increase in the power output.

In a test the quantity of water discharged by the sluices was measured and the effect on one of the units determined while it was running at 6-10 gate. The power was increased about 9 per cent, and the effect of an 18-in. rise of water can be compensated for.

The Barton plant was designed, and its erection supervised by Gardner S. Williams, consulting engineer, Ann Arbor, Mich.

Pavement Near Car Lines Heaves During Cold Spell

Freezing Water Between Rails and Blocks Damages Streets in Seattle and Other Pacific Coast Cities

By J. THOMAS DOVEY

President, Seattle Engineering Company

HEAVED upward by frost action to heights of several inches in the vicinity of street railway tracks, the pavements in Seattle and other cities in the western sections of the North Pacific States suffered severe damage during January of this year, a month marked by the longest duration of low temperatures recorded in the last ten years. Although examinations were made on streets surfaced with brick, brick block, sand stone block, creosoted wood block and asphalt, no particular type of pavement appeared to be immune from the effects of the cold, but the one fact made clear by these investigations was that only those streets which carried street railway tracks exhibited any evidences of deterioration. It is apparent that the heaving was caused by the freezing of water which collected between the rails and the paving material adjacent thereto, a result attributable to improper facilities for drainage or lack of a proper filler between the rails and the paving blocks.

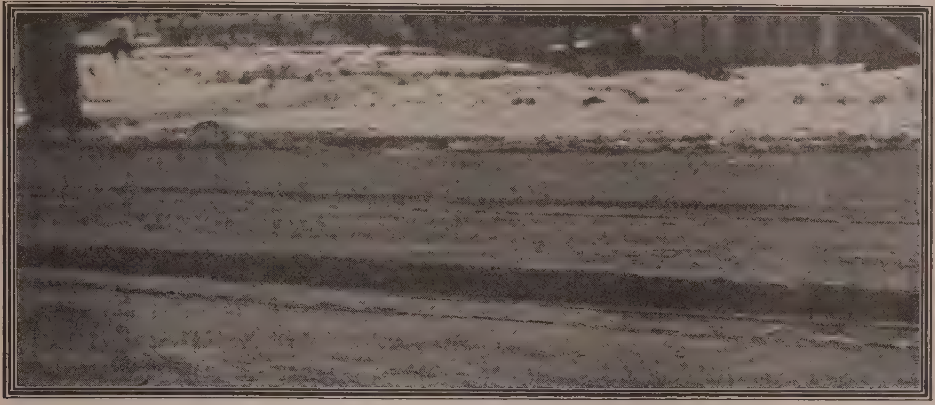
Winter Temperatures

As the greater number of the investigations made were in Seattle and vicinity and as the temperature conditions in the other cities closely approximated those of Seattle and do, as a general rule, follow them quite closely, temperature figures are given for Seattle only. The average winter temperatures of the North Pacific Coast cities are comparatively high and very equable, that of Seattle for the months of November, December, January and February for the past five years being 42.35 deg. Fahr. For the past ten years the average for the same months was 42.33 deg., the maximum range of average monthly temperature for these months during the entire ten years being only 15 deg. The lowest temperature recorded during the last ten years was on Jan. 15, 1907, when the mercury reached 11 deg. above zero. The greatest duration of low temperature, with the exception of January, 1915, was in the same month of the same year when there were 20 days whose minimum temperature was under 30 deg. These days, however, were not of consecutive duration.

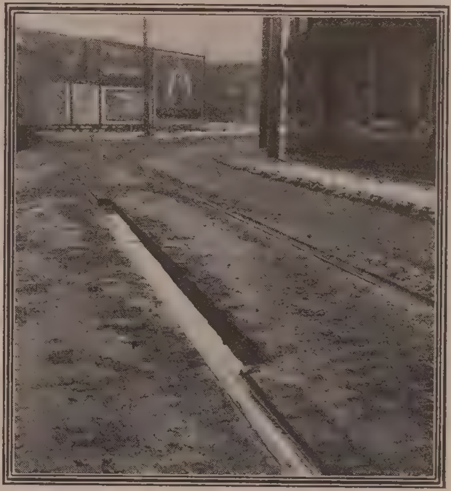
Between the dates of Dec. 29, 1915, and Feb. 1, 1916, there were 27 days whose minimum temperature was less than 30 deg., the average mean temperature being 31 deg., so that this is the longest duration of low temperature that has visited Seattle during the past ten years. Corresponding conditions were felt in other coast cities. There was a light snow fall at intervals during the month of January which had the effect of continuing the refrigeration during the few days when the minimum temperature was above freezing, but there was never at any time during that month over a few inches of snow on the ground at one time.

Streets examined were paved with brick, brick block, sandstone block, creosoted wood block and asphalt and no frost action was noticeable upon any streets examined except those on which car lines were laid.

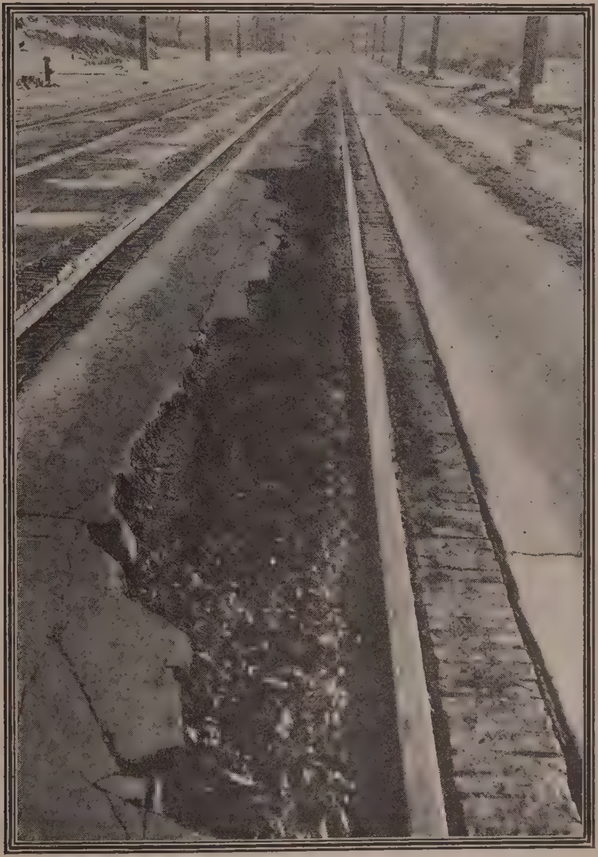
How Cold Weather Damaged Pavement Surfaces in Seattle by Heaving



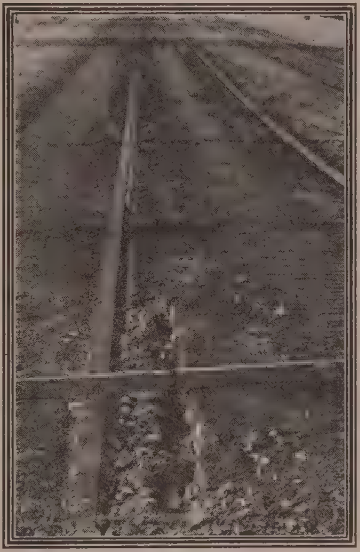
1—AN ASPHALT PAVED STREET IN WHICH THE TOP OF THE BRICK ALONG THE STREET CAR RAILS HAS BEEN HEAVED 2½ INCHES



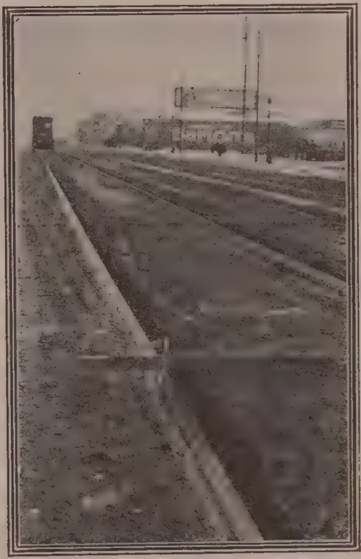
3—IN SOME PLACES STREET CARS COULD NOT PASS UNTIL HEAVED BRICK HAD BEEN REMOVED



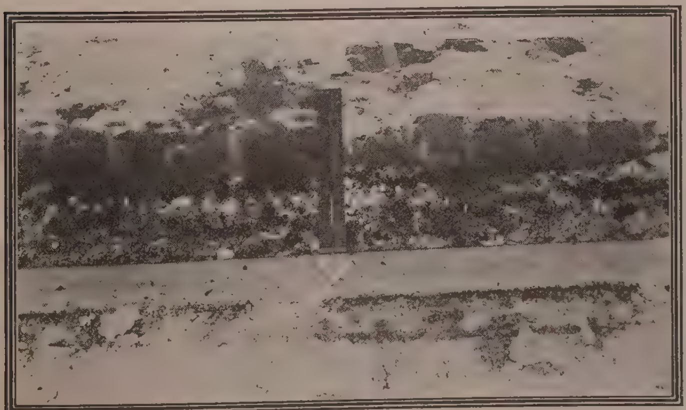
2—HOW SEATTLE STREETS BETWEEN CAR TRACKS HAVE BEEN DAMAGED BY FROST ACTION—THE BREAKING OF THE ASPHALT CONTINUED AT INTERVALS FOR A NUMBER OF BLOCKS



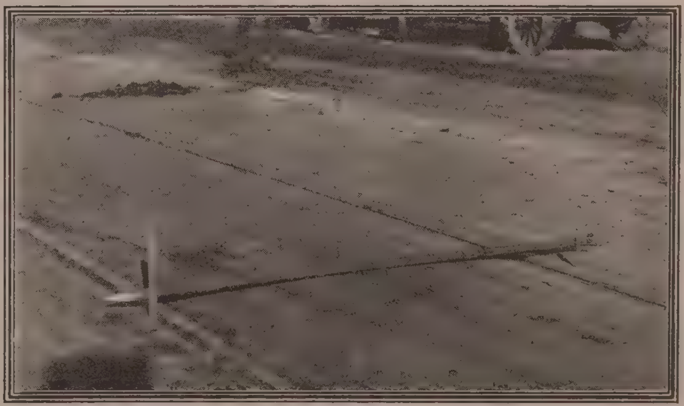
4—HOW THE STREET CARS HAVE POUNDED DOWN PROJECTING TOPS OF PAVING BRICK



5—STRAIGHT EDGE AND RULER INDICATE RISE OF TOP OF BRICK ABOVE TRACK RAIL



6—A BRICK PAVED STREET WHICH WAS HEAVED 5 INCHES ABOVE THE RAIL, BLOCKING CAR SURFACE



7—THE HEAVING OF THIS WOOD BLOCK PAVEMENT OCCURRED, GENERALLY, ONLY BETWEEN THE CAR TRACKS

All the damage to the paving was contiguous to the car tracks. The streets were of various widths and grades varying from 24 to 60-ft. roadways and from 0 to 7 per cent grades, in light, medium and heavy traffic districts, but the results noted did not seem to be affected by any of these conditions.

Extent of Damage

The results of the examinations of the pavements are shown by the accompanying photographs. No. 1 shows the general condition of heave of the paving brick along an asphalt section. The brick in all cases was originally laid so that their tops were coincident in elevation with the top of the rail. In photo 1 the top of the brick is approximately 2½ in. above the top of the rail and this condition existed at this location for a distance of about 100 ft. in each case, the brick gradually receding to an elevation of about ¼ in. above the normal for the balance of the block. The brick next to the track is a bull-nosed pattern, as may be seen in photo 2, which shows the brick removed on the same street a few blocks away. This street is in a residence district and supports a medium residence traffic of light vehicles, principally automobiles, and has been in service since 1908 and 1909. The bricks were originally laid on a sand cushion with cement grout. A filler of the same material was run between the brick and the track, but this has long since been broken away by the street car and other traffic and has left practically no filler between the brick and the rail.

Photo 2 shows the same street at another location and the frost action upon the brick and asphalt between the tracks. It will be noted that the bricks here shown have been raised both on the outside and inside (on the left-hand track) of the rail. The breaking of the asphalt continued at intervals over a number of blocks in more or less degree. This part of the street was paved in 1908, the roadway is 40 ft. in width. The gradient is less than 1 per cent.

Photo 3 shows a street paved entirely with vitrified paving brick, 8½ x 4 x 2¾ in., the exposed edges of which are rounded to a radius of ¼ in. The paving was laid in 1909 and sustains a heavier traffic than the previous streets noted, but could not be termed a heavy traffic thoroughfare. The width of roadway is 60 ft. and the gradients vary from 5 to 0.05 per cent. This street showed a consistent raising of the brick on both the inside and outside of the car tracks and only at intervals were large heaves noted.

Levels Taken

As it was desired to show an average condition of this type of paving direct levels were taken over approximately 1000 lin. ft. of street (inside and outside of both rails) which gave the following results:

Length, approximately 2000 ft.; average elevation of top of brick inside and outside rail, above top of rail, taken at 5-ft. intervals, 0.0533 ft. Length 250 ft., showing highest elevation of brick above top of rail, 0.124 ft. Highest average of any two readings taken, 0.1693 ft. Maximum reading 0.1732 ft.

About 55 lin. ft. of brick between the tracks had been removed contiguous to where the readings were taken, as the raise of the brick in that portion had been high enough to interfere with street car traffic. Numerous instances, particularly at cross streets, showed the effect of the impact of traffic on the paving material that had been forced above the grade of the tracks. In more cases of this kind the material was either forced out or reduced to small pieces, as shown in photo 4, which is a portion of the same street shown in photo 3, some blocks distant. The gradient at this point is 2 per cent and the width of roadway 44 ft.

Blocks Heaved 5 Inches

Photo 5 shows a pavement of brick laid 5 years ago, where the brick along the car tracks has been removed because of its interference with traffic. The grades on these streets are light and the traffic of medium character. The tracks shown had in most cases been cleaned and been kept clear of snow by the car traffic. In photo 6 is shown a track in a small town in northern Oregon which had not had the advantage of constant traffic and cleaning. Here the brick, laid in 1912, raised a full 5 in. above the rail and temporarily precluded the use of the track for car service.

All of the brick paving examined was of practically the same construction and showed that either cement grout or small brick fillers had been used between the track and the paving material, but that the fillers had in all cases broken up so as to cease to fulfill their function.

The heave in a wood block pavement is shown in photo 7. This pavement was laid in 1909 and sustains a fairly heavy downtown traffic. It is laid on a 3.93 per cent grade with a 60-ft. roadway. The photograph does not indicate graphically the actual extent of the damage caused by the heaving. This pavement showed a greater height of heave than any of the brick or asphalt pavements examined, the heave measuring from 3 to 3½ in. The heaving appeared, generally, in the center of the car tracks and at no point on the outside of the tracks was any noticeable heave cause by frost action.

Ice Filler Along Rails

As in the case of the brick paving the wood block paving did not have a close bond to the rail, a chamfered block next the rail being used with no filler. This allowed the formation of an ice filler between the block and the rail. That it was the expansion of the ice formed between the rail and the block that caused the heaving of the material was later demonstrated when wood blocks, frozen in the laboratory, showed an actual contraction in size in the freezing tests. It was noted that at each rail joint, where the opportunity for the admission of water and snow was made easier, by reason of the larger opening, that the heaving was greatest at these points. These blocks are of creosoted Douglas fir, 3¾ x 3½ x 6 in., and were laid upon a sand and cement cushion which was found to have held its place much better than the sand cushion in the portion of streets outside the tracks, which had been laid without mixing with cement.

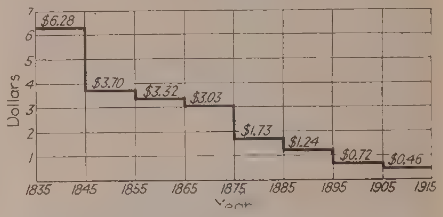
All the heaving investigated was due to the lack of or improper drainage, which allowed the water to stand against the rail till it became frozen, or to the lack of proper fillers between the material and the rail, which allowed the snow and ice to become driven into the space by the action of the car wheel and other vehicles and there to expand when the temperature lowered.

In all cases, in four different cities, the paving that was affected was in and around car tracks which were laid with T rail. Both brick and wood block that were laid against girder rails, which permitted a close bond and did not allow the formation of ice against the tracks, showed no heaving as the results of the low temperatures.

Streets paved with all three materials, upon which car lines were not laid, showed no action caused by frost or freezing.

Fire Losses Show Striking Decrease

Evidence of the effect of careful selection of risks and of the great increase in the number of fire-resistive buildings and in the use of sprinkler systems is seen in the striking reduction in fire losses reported by the Manufacturers Mutual Fire Insurance Company. As shown in the accompanying diagram, the average fire loss in dollars per thousand dollars of insurance has decreased from $6.28 in the decade 1835-1845 to $0.46 in 1905-1915.



FIRE LOSSES AVERAGED BY DECADES IN DOLLARS PER THOUSAND DOLLARS OF INSURANCE

Since 1902 the water damage due to sprinkler accidents is included with the fire losses, and since 1913 the damage by windstorm has also been included. As this is a mutual company, in which the fire losses are assessed pro rata upon all policy holders, the records show clearly the direct benefits to all insurers as a result of the strict limitations of risk and the use of sprinkler systems.

Vehicle Loads Now Limited in Ontario

A LAW limiting the load of vehicles operating on the highways of the Province of Ontario, Canada, has just been enacted. While a number of the states of the union, as well as European countries, have adopted similar measures, Ontario is the first of the Canadian provinces to have such a law.

The provisions of the bill are briefly as follows:

1. No vehicle shall carry a load, including the vehicle itself, greater than 12 tons or more than 4½ tons on any one wheel.
2. No vehicle shall be operated on the highways which has any flange, rib, clamp or other device attached to its wheels which would injure the highways.
3. No vehicle shall carry a load, including the vehicle itself, which will impose a greater weight than 650 lb. per inch of tire.
4. Under certain conditions permit may be granted for moving a heavier load, but even when such a permit has been secured the operator or owner shall be responsible for all damages which may be caused.
5. No vehicle shall have a greater width than 90 in., except traction engines, which are limited to 110 in.

The measure was enacted into law through the energy of its introducer, George S. Henry, member of the Legislative Assembly of Ontario for East York.

Patrol System Improves Condition of Dirt Roads 50 Per Cent at Low Cost

System Started in Clayton County, Iowa, Three Years Ago Has Proved Its Value in Efficiency and Economy in Maintenance Work

By E. B. TOURTELLOT
County Engineer, Clayton County, Iowa

THREE years ago Clayton County, Iowa, started a patrol system for the maintenance of its dirt roads. To-day the condition of the roads in the county is 50 per cent better than it was then. They are better drained, better dragged and have easier grades. This is attributed to the fact that experienced road men are on the job at the right time.

USE DRAG AT RIGHT TIME

To drag a road at the right time is acknowledged to be the secret of a well-kept road. The right time to drag roads is usually a matter of judgment with the individual, or, perhaps, a lack of judgment, since little attention is paid to the character of the soil and the season of the year. The result is that many dirt roads are dragged either too early or too late. There must be organization to give good results and that organization must have a head in order to operate in an efficient manner. Realizing the lack of system in the old methods of road maintenance, the writer conceived the idea of organizing the labor on Clayton County roads into a patrol system, the head of which was to be the board of supervisors and the engineer. The system was intended not merely for road dragging purpose, but also for repair and permanent work.

The county is located in the northeastern part of Iowa, and borders on the Mississippi River. It comprises about 810 sq. miles of area and is cut by two fair-sized rivers.

Its elevations range from 600 to 1250 ft. above sea level. All the streams in the county are cutting rapidly. The surface over the larger part of the country is made up of a light clay, which washes very readily, and, at the same time, drains rapidly. This permits early dragging.

There are over 1350 miles of roads in the county, the county system totaling about 226 miles. The towns, with the exception of three, are situated in the valley at an elevation of from 555 to 600 ft. above sea level, or about 400 to 500 ft. below the surrounding ridges. This requires a limiting grade for the road somewhat in excess of the average requirements.

ROADS NEED MORE THAN AVERAGE AMOUNT OF REPAIRS

The roads of Clayton County need more than the ordinary amount of care if they are to be kept passable. Gulleys of from 8 to 10 ft. deep form within a few days along the center of hill roads, where proper care had been lacking in turning the water from the ruts.

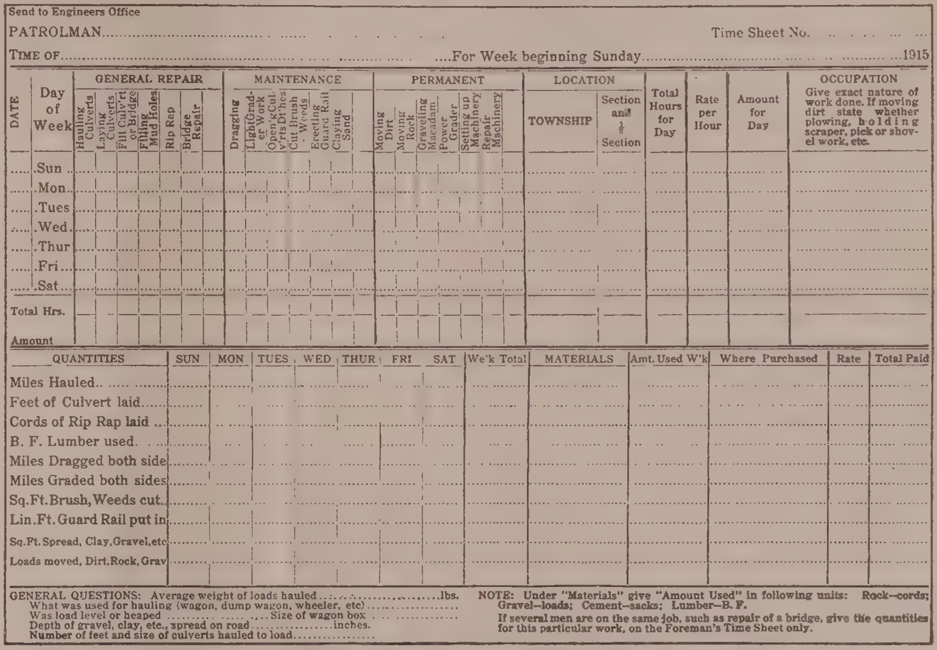
The patrol system used covers the entire mileage of the county roads, the average length of each patrol being 10 miles. This length was reduced during the past season to about 7 miles in parts of the county.

SUPERVISORS SELECT PATROLMEN

The selection of patrolmen rests with the supervisors, each attending to the covering of the road in his district. Men of experience in road work, and capable of handling a gang, if necessary, are the type selected as a rule, although it is sometimes difficult to get the right man.

PATROLMEN UNDER CONTRACT

The patrolmen are under a written contract to work for the county at the time and place designated by the board of supervisors or the engineer. In the past they were required to give a bond to insure the care and return of tools. This year this requirement was struck out, as it had not been found necessary. The average price paid to patrolmen throughout the county is 27½ cents per man per hour. A man and team is paid 47½ cents per hour, and 10 cents per hour is paid for each extra horse. Extra help is paid for at the rate of 25 cents per man per hour and for a man and team at 45 cents per hour. The patrolman is authorized to hire assistants for dragging.



Send to Engineers Office
PATROLMAN........................ Time Sheet No. ....
TIME OF........................ ....For Week beginning Sunday........................1915

DATE	Day of Week	GENERAL REPAIR							MAINTENANCE							PERMANENT							LOCATION		Total Hours for Day	Rate per Hour	Amount for Day	OCCUPATION
		Hauling Culverts	Laying Culverts	Fill Culv'rt or Bridge	Filling Mud Holes	Rip Rap	Bridge Repair		Dragging	LightGrader Work	Open'gCul-v'rts Dt'hes	Cut Brush Weeds	Erecting Guard Rail	Claying Sand		Moving Dirt	Moving Rock	Graveling Macadam	Power Grader	Setting up Machinery	Repair Machinery		TOWNSHIP	Section and ½ Section				Give exact nature of work done. If moving dirt state whether plowing, holding scraper, pick or shovel work, etc.
	Sun																											
	Mon																											
	Tues																											
	Wed																											
	Thur																											
	Fri																											
	Sat																											
Total Hrs.																												
Amount																												

QUANTITIES	SUN	MON	TUES	WED	THUR	FRI	SAT	We'k Total	MATERIALS	Amt. Used W'k	Where Purchased	Rate	Total Paid
Miles Hauled													
Feet of Culvert laid													
Cords of Rip Rap laid													
B. F. Lumber used													
Miles Dragged both side													
Miles Graded both sides													
Sq.Ft. Brush, Weeds cut													
Lin. Ft. Guard Rail put in													
Sq.Ft. Spread, Clay, Gravel, etc													
Loads moved, Dirt, Rock, Grav													

GENERAL QUESTIONS: Average weight of loads hauled........................lbs.
What was used for hauling (wagon, dump wagon, wheeler, etc)........................
Was load level or heaped .... Size of wagon box ....
Depth of gravel, clay, etc., spread on road................inches.
Number of feet and size of culverts hauled to load................

NOTE: Under "Materials" give "Amount Used" in following units: Rock—cords; Gravel—loads; Cement—sacks; Lumber—B. F.
If several men are on the same job, such as repair of a bridge, give the quantities for this particular work, on the Foreman's Time Sheet only.

PATROLMAN'S TIME SHEET PROVIDES BASIS OF COST DATA COMPILATIONS

All road tools are supplied by the county with the understanding that the patrolmen will take reasonable care of them. At the close of the season an inventory of all tools, supplies and road material is made and sent to the engineer.

PRIMARY OBJECT OF SYSTEM

The primary object of the patrol system is to keep the road in passable condition. In addition to maintenance the patrolman has charge of any permanent work outside of blade grader work, which is done on his patrol. If advisable, one or more patrolmen are called to the assistance of another on any work of considerable size, the patrolman of the district in which the work is done being in charge. In no case, though, is dragging or emergency repair work neglected for this purpose. The patrolman is also used on bridge or other repairs on township roads in the vicinity of his patrol.

Not all of the patrolmen depend on road work for a living, although several were employed throughout the season. They are, however, under obligation to report for the county at any time the board of supervisors or engineer demand their services.

All maintenance work on the patrol system is under the inspection of the supervisor or engineer. At the beginning of the season a trip is usually made by the supervisor of the district, or by the engineer, in company with the patrolmen, and the work of the season is outlined. All permanent work is indicated by the engineer, who superintends the construction.

SHEETS USED FOR TIME-KEEPING

At the end of every week each patrolman sums up his time. He sends the time sheet to the engineer, who checks it, and, if any mistake is found, returns it for correction.

Claim sheets are filed at the end of the month and the time shown must check with the time sheets. All time sheets are retained in the engineer's office. A space is reserved on the sheet for quantities of work done.

Requisition books are supplied each patrolmen, and no claim is allowed any dealer unless a duplicate requisition is attached. When the patrolman pays cash for the supplies or tools a receipt from the dealer must be attached to his claim.

COST OF DRAGGING LESSENED

The total cost of dragging on the county system for 1915 was 56½ cents per mile per round trip, as compared with an average cost of 71 3/10 cents per mile per round trip for all the counties of the State.

The average rate paid throughout the State per hour for a man and a team during the past season was 47½ cents per hour, the same as paid Clayton County's patrolmen. The time required to drag one mile of road per round trip is about one hour. The average number of horses used to each drag last season was three, which means a cost of 47½ cents plus 10 cents or 57½ cents per mile per round trip. This checks within a cent of the average cost shown above. If a mile can be double-dragged in one hour with three horses in Clayton County it surely should be done in any other county in the State where the average rate is shown to be 71.3 cents. In other words, the average county in the State is paying the price of $1\frac{1}{4}$ miles for the dragging of one mile of road.

WHY THE PATROL SYSTEM PAYS

The patrol system pays because it is more efficient. Results have shown that the county roads in Clayton County are today fully 50 per cent better than they were three years ago. They are better drained, better dragged, have better grades and are better for passing. This is because experienced road men are on the job when they should be. They have easier and wider roadways because men are working constantly to eliminate the heavy grades and to widen the narrow places.

It is the economical system. Figures show that for 1915 Clayton County paid less per mile for the dragging of a county road than the average county in the State. Furthermore, when roads are dragged at the right time, the surface is left in better condition than when dragged too early or too late, and the cost of maintenance is diminished in proportion.

Geodetic Survey Doing Valuable Work in Field of Terrestrial Magnetism

Because of its extensive compilations of data relating to the change of the compass direction from time to time, the U. S. Coast and Geodetic Survey is able to furnish promptly information of priceless value in the adjudication of disputed land boundaries, the bearings of which were referred to the compass direction when originally laid out, 100 to 150 years or more ago. Meridian lines for the use of surveyors have been established at many county seats throughout the country, magnetic data at sea have been accumulated on cruises of the coast survey vessels, and five magnetic observatories, where the countless fluctuations of the earth's magnetism are continuously being recorded, are at present in operation under the direction of the Survey. At the present time in the New England States, the north end of the compass is moving west at the rate of about 6 min. per annum. Thus, instead of a change of 1 deg. in 20 years, as is frequently assumed, there may be a change of 1 deg. in 10 years or even in 5 years or less, depending entirely upon geographic location.

Portable Telephone for Forest Service Control

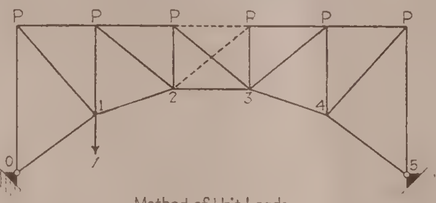
District rangers and field men of the forest service during the coming season will use a portable telephone, made of aluminum and weighing $2\frac{1}{2}$ lb. This instrument, which is to replace the 10-lb. telephone set now in use, is provided with a few yards of light emergency wire and a short piece of heavy wire to make the ground connection. When it is to be connected for use, one end of the emergency wire is thrown over the telephone line and the two ends are connected to the portable instrument which, in turn, is connected to the ground wire. At the receiving station the call from the portable instruments comes in as a screeching sound from a small megaphone-shaped apparatus specially provided. The equipment was invented by R. B. Adams, a Forest Service employee at Missoula, Mont.

Truss Deflections Accurately Determined by Angle Changes and Elastic Weights

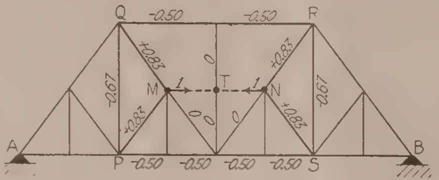
Different Methods Explained and Compared—Practical Formulas and Diagrams, Designed to Save Time, Are Illustrated by Examples—Part 1

By D. B. STEINMAN
Special Assistant to Gustav Lindenthal, Consulting Engineer, New York City

RECOGNIZING the necessity for accuracy in the determination of elastic deflections of truss bridges, particularly for long-span and indeterminate higher structures, there is here developed a treatment of truss deflections including some new formulas and diagrams, designed to save time in the accurate analysis of such problems. Four general methods which can be used in the solution of these problems are explained and compared. The method of unit loads, the method of angle changes and the method of elastic weights are described in detail and applied to examples illustrating the advantages of each method —examples including the two-hinged arch and various simple truss problems. The relations between influence lines for stresses or reactions and deflection diagrams are also considered.



Method of Unit Loads Applied to a Two-Hinged Arch
FIG. 1



To Find the Change of Distance Between Two Points of a Truss
FIG. 2

APPLICATIONS AND FIRST STEP

In the planning and execution of any important bridge project a number of problems arise which involve a determination of the elastic deflections of the structure. In a previous article ("The Elastic Curve Applied to the Design of the Sciotoville Bridge" in the ENGINEERING RECORD of Aug. 28, 1915, page 258) the writer showed how a curve of deflections is used as the basis for the design of indeterminate structures. Other purposes for which deflection studies are necessary are: Comparing the maximum deflections in different designs for a given project; making provision for camber in long spans; laying out or checking a cambered truss in shop or yard when assembled for reaming; fixing the elevations for falsework or centering; checking the elevations of a truss or arch after it is swung free from the falsework; checking the elevations of a cantilever, or of a truss erected by the cantilever method, at different stages of the erection; planning or controlling jacking operations or other adjustments during erection; designing latching details at the ends of a drawbridge; designing expansion details and determining the movement to be provided for at rocker or roller bearings; and making estimates of the secondary stresses resulting from the deformations of the structure.

The first step in determining the deformations of a truss under any loading is to calculate the elastic strain (elongation or compression) produced by that loading in each member of the structure. This strain is given by the familiar formula

$$\Delta s = \frac{S.s}{E\,A} \qquad (1)$$

where S is the stress (tension or compression) in the member, determined by any of the usual methods of stress analysis, s is the length of the member and A its area of cross-section. In investigating the deformations due to temperature, the above formula is replaced by

$$\Delta s = e.t.s \qquad (2)$$

where t is the change in the temperature of one or more points of the structure. The the member and e is the coefficient of expansion. The sign of Δs is taken + or — according as it represents an increase or decrease in the length of the member.

GENERAL PROBLEM—METHODS OF SOLUTION

The general problem of truss deflections may be thus stated: Given the elongations or compressions Δs in all the members of a truss, calculated by eq. (1) or (2), it is required to find the resulting deflection δ of problem thus stated is a purely kinematic one; its solution is independent of the loading and depends only upon the geometry of the structure. There are four different methods of solving this problem:

1. Graphically—By the Williot Diagram.
2. Analytically—By the Method of Unit Loads.
3. By the Method of Angle Changes.
4. By the Method of Elastic Weights.

As will appear later, each of these methods has its peculiar merits and, as there are different investigations or problems for which each is best adapted, the bridge engineer will find it advantageous to have all four methods at his disposal. In general, each example is selected to illustrate the advantages of the particular method applied.

1—THE WILLIOT DIAGRAM

This method is too well known to require explanatory description here. The Williot diagram is simply a graphic expression of the geometric relations between the given strains, the resulting angular rotations of the members and the desired panel point deflections. The strains are plotted as vectors, and the resulting deflections of the panel points are scaled directly from the diagram.

The advantage of this method is the completeness of its information. It gives, in a single construction, both the horizontal and vertical displacement of every point in the structure. However, in common with all graphic methods, the Williot diagram possesses the disadvantage of lack of precision when compared with analytical procedures; a slight inaccuracy in a single line, instead of being confined in its effect to the immediate panel point, will introduce errors, usually increasing in magnitude, in the positions of all the succeeding points in the diagram.

2—THE METHOD OF UNIT LOADS

When the deflection of a single point or of a small number of points is desired, the method of unit loads is best, being superior to the Williot diagram in speed as well as precision. It consists in applying a load of unity at the panel point whose deflection is sought, acting in the direction of the desired deflection, and finding the resulting stresses in all the members of the structure; when these stresses S_1 are multiplied by the given strains Δs in the respective members, the algebraic sum of the products will give the desired deflections δ; thus,

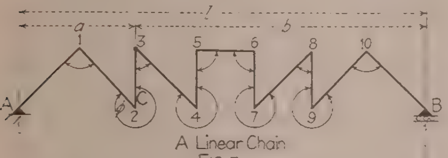
$$\delta = \Sigma\, S_1.\Delta s \qquad (3)$$

For a simple proof of this formula, consider any member and any panel point of a truss. Let S_1 be the stress in the member produced by a load 1 at the panel point, and let δ be the deflection of the panel point produced by any elongation Δs in the member. Then S_1 and 1 are a pair of forces in equilibrium and Δs and δ are a pair of mutually consistent displacements of their points of application. By the principle of "virtual velocities," or the fundamental law of machines, the ratio of two forces in equilibrium is equal to the inverse ratio of any small, simultaneous displacements of their points of application in the directions of the forces. Consequently we have the proportion

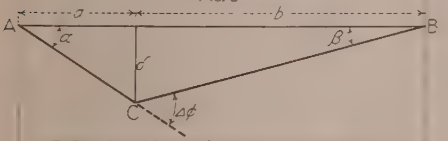
$$S_1 : 1 = \delta : \Delta s$$

Hence $$\delta = S_1.\Delta s \qquad (3a)$$

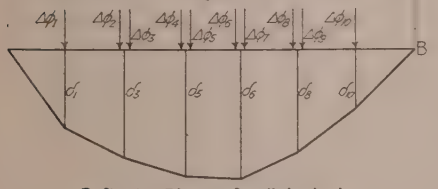
This represents the contribution of a single member to the deflection of any panel point.



A Linear Chain
FIG. 3



Deflection Triangle for a Single Angle Change
FIG. 4



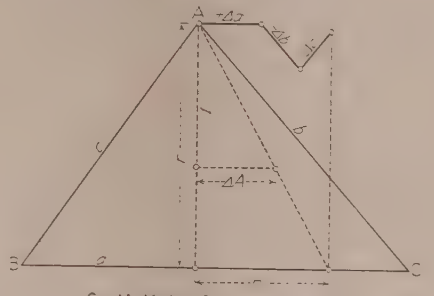
Deflection Diagram for all the Angle Changes in Linear Chain.
FIG. 5

Adding such expressions for all the members of a structure, we obtain the total deflection of the panel point as given above in (3).

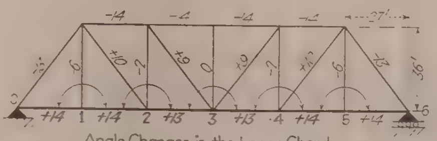
It should be noted that the values of Δs are those due to the given loading, while the values of S_1 are independent of that loading but depend only upon the location of the panel point under investigation and the relative dimensions of the structure.

EXAMPLE 1—TO FIND THE DEFLECTIONS OF A TWO-HINGED ARCH

In the two-hinged spandrel-braced arch represented in Fig. 1, it is required to find the vertical deflection of each of the lower panel points 1, 2, 3, 4, caused by the loading ΣP. The stresses S due to this loading and the resulting values of Δs are determined for all the members. A unit load is then applied at panel point 1, and the stresses S_1 calculated with the arch rendered statically determinate by removing the redundant members shown by dotted lines. This simplification corresponds to neglecting a system of stresses comprising the stresses S_1 in the redundant members and the stresses which these would produce in the rest of the members, and is justified because this system of stresses is in internal equilibrium without the aid of any external forces, and would therefore yield a zero contribution to the value of $\Sigma\, S_1.\Delta s$. With the values of S_1 thus determined, the deflection of panel point 1 is given by $\delta = \Sigma\, S_1.\Delta s$. As the structure and given loading are symmetrical, panel point 4 will have the same deflection. The unit load is then applied at panel point 2 in order to find the deflections at points 2 and 3.



Graphic Method for Angle Changes
FIG. 6



Angle Changes in the Lower Chord
FIG. 7

The above device of omitting the redundant members is a valuable time-saver in finding deflections in indeterminate structures. For example, in finding the deflections in any span of a continuous truss, after the values of Δs have been determined, the span is severed from the adjoining spans by omitting the top-chord member over each pier before finding the values of S_1.

EXAMPLE 2—TO FIND THE CHANGE OF DISTANCE BETWEEN TWO POINTS OF A TRUSS

In the web system shown in Fig. 2, M N represents a longitudinal strut provided for bracing the vertical post at T. It is assumed that the strains Δs in all the members produced by maximum loading are known, and it is required to find the resulting change in the distance M N so that suitable provision may be made for such expansion.

For this purpose a unit force is considered applied as shown at the points M and N, and the resulting stresses S_1 are marked in the figure. It will be observed that these stresses are confined to the members indicated by heavy lines. Multiplying these values of S_1 by the known values of the strains Δs in the same members, the sum $\delta = \Sigma\, S_1.\Delta s$ will give the change in the distance M N. Since the unit force was assumed to act in such direction as to draw M and N together, a plus result for δ represents a shortening and a minus result an increase of the distance M N.

For finding the deflections of one or more isolated points, as in the above examples, the method of unit loads is evidently the most expeditious. As the number of points is increased, however, it loses its advantage over other methods as it requires a new stress analysis of the entire truss for each deflection desired. When the vertical deflections of a large number of points in a structure are desired, the third or fourth of the above methods becomes most advantageous; these are both more precise than the Williot diagram and more expeditious than the method of unit loads. They are particularly adapted for plotting truss deflection diagrams, influence lines for deflections, and "elastic curves" for the design of indeterminate structures.

The methods of angle changes and of elastic weights are based on principles which are analogous but not identical. The second of these methods is recommended for its greater convenience of application, nevertheless the other method is more commonly used and will be presented first on account of its greater simplicity of demonstration.

3—THE METHOD OF ANGLE CHANGES

Consider any chain of lines A-1-2-3—B, such as illustrated in Fig. 3, with one end fixed and the other free to move horizontally on its support. If the lengths of the bars and the angles between them are fixed, the position of any joint is definitely determined. A change in any of the lengths or angles will cause a displacement of all the joints. It is required to determine such displacement. For this purpose the effects of the "angle changes" and "line changes" will be considered separately, confining attention at first to the effect of the angle changes.

To find the effect of an angle change at one of the joints C, all the other angles must be considered fixed, so that the entire chain may be conceived as composed of two rigid segments (AC, BC) hinged together at the given joint. If the angle φ at this joint is increased by any amount Δ φ, the two segments will rotate downward through respective angles α and β governed by the relation (from the triangle, Fig. 4)

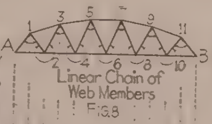
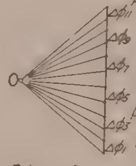
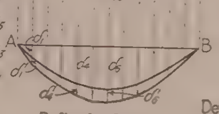


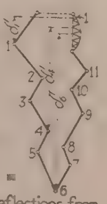
FIG. 8



Polygon for Angle Changes
FIG. 9



Deflection Diagram
FIG. 10



Deflections from Line Changes
FIG. 11

$$\alpha + \beta = \Delta\, \varphi \qquad (a)$$

The resulting deflection of the hinge point C, common to both segments will be

$$\delta = a{\cdot}\alpha = b{\cdot}\beta \qquad (b)$$

From equations (a) and (b)

$$\delta = \frac{a{\cdot}b}{l}\Delta\, \varphi \qquad (c)$$

as the expression for the maximum ordinate of the deflection triangle ACB, Fig. 4.

Comparing eq. (c) with the expression for the corresponding ordinate of the moment triangle for a "weight" Δ φ applied at C, the two triangles prove to be identical. In other words, the deflection triangle for any angle change is identical with the moment triangle for a weight equal to the angle change and applied at the same point. To find the combined effect of all the angle changes, we could add the superimposed ordinates of the several moment triangles; but this is equivalent to constructing directly the moment diagram (funicular polygon) for all the angle changes applied as weights at the respective joints. The ordinates of this deflection diagram, Fig. 5, multiplied by the pole distance used in its construction, will represent the total deflections caused by the angle changes.

It is evident that a chain of lines, such as treated above, may be formed from the members of a truss, selecting those which connect the panel points whose deflections are desired. We have thus proved the general principle of the method of angle changes, which may be stated as follows:

> The deflection diagram of a chain of truss members, if the line changes are neglected, is identical with the moment diagram obtained by applying as a weight at each joint the angle change at that joint.

It will now be shown how the angle changes in such a chain of truss members may be determined.

Determination of the Angle Changes

When the strains Δs in three members forming a triangle are known, the resulting changes in the angles of the triangle, Fig. 6, may be determined either analytically or graphically. If a, b, c, denote the lengths of the three sides; Δa, Δb, Δc, their respective elongations (negative if compression); and A, B, C, the opposite angles, respectively, then the change in any angle A is given by the formula

$$\Delta A = \left(\frac{\Delta a}{a} - \frac{\Delta b}{b}\right)\cot C + \left(\frac{\Delta a}{a} - \frac{\Delta c}{c}\right)\cot B \qquad (4)$$

If the strains Δs have not yet been calculated, a short-cut may be applied by using the intensities of stress or unit stresses u defined by

$$u = \frac{S}{A}$$

If u_1, u_2, u_3, are the unit stresses in the three members, a, b and c respectively, the above formula (4) may be written in the following form:

$$E.\Delta A = (u_1 - u_2)\cot C + (u_1 - u_3)\cot B \qquad (5)$$

The angle changes may be found graphically by the construction shown in Fig. 6. Using any convenient scale, the vector summation of the three strains is constructed as a chain of lines (Δa, Δb, Δc), all elongations being plotted in the direction of the cyclical succession of the sides of the triangle ABC and all compressions being plotted in the reverse direction. To find the change in any angle, this chain of lines is projected upon the opposite side of the triangle. This projection m, measured to the linear scale of the plotted strains and divided by the corresponding altitude r, will give the actual change in the angle in radians. Instead of performing this division, the angle change may be obtained directly as the intercept ΔA drawn parallel to m at a unit distance from the vertex. The direct analytical equivalent of this method is represented by the formula

$$\Delta A = \frac{\Delta a - \Delta b.\cos C - \Delta c.\cos B}{r} \qquad (6)$$

To find the total change of angle $\Delta\varphi$ between two chord members the three component angle changes may be found separately from the respective triangles by eq. (4), (5) or (6).

Examples—Method of Angle Changes

Example 3—To find the deflections of the lower chord of a simple truss by the method of angle changes.

Fig. 7 gives the unit stresses u (in thousands of pounds per square inch) in all the members of a truss under the action of a symmetrical load. Treating the lower chord as a chain of lines, the angle changes at the joints are calculated by eq. (5). Thus,

$$E.\Delta\varphi_1 = (-13-14)\ 0.75 + (-13+6)\ 1.33 + (10+6)\ 1.33 + (10-14)\ 0.75 = -11.25$$

$$E.\Delta\varphi_2 = 0.75\ (-14-10+9-13) + 1.33\ (-6-10+9+2) = -27.65$$

$$E.\Delta\varphi_3 = 2\ [0.75\ (-14-9) + 1.33\ (-2-9)] = -63.80$$

Applying these angle changes as weights at the respective panel points, the resulting shears and bending moments are obtained successively by summation as follows:

Panel Point	$E \times$ Angle Change $E.\Delta\phi$	Shear	Moment M	Deflection δ in.
0			0	0
		70.80		
1	11.25		70.80	0.76
		59.55		
2	27.65		130.35	1.41
		31.90		
3	63.80		162.25	1.75

In the above table, the values of $E.\Delta\varphi$ were used instead of the angle changes, and the panel length was assumed as unity in figuring the moments (M). Consequently the values obtained for M must be multiplied by the panel length and divided by E (= 30,000) to obtain the deflections, which are listed in the last column.

The results for δ in this case require no correction for the line changes of the members in the chain, as all these members are horizontal and consequently their line changes can have no effect on the vertical deflections.

Example 4—To find the deflections of the upper chord panel points of a truss.

In a truss with verticals, like that of Fig. 7, the lower chord deflection may first be found as explained above; the deflections of the upper panel points are then equal to those of the lower panel points augmented (or diminished) by the compressions (or elongations) of the respective posts (or hangers). This rule can be expressed by the formula

$$\delta_l = \delta_u + \Delta v \qquad (7)$$

The deflections of the upper panel points may also be found directly by treating the upper chord as the chain of lines and applying the method of angle changes just as in the preceding example. In this case, however, the results obtained for the deflections δ must be corrected for the effect of the line changes in the members of the chain. If the loading is symmetrical and the top chord straight, the correction is simply made by adding the vertical component of the compression in the end posts.

Example 5—To find the deflections of a truss by means of a chain of web members.

Instead of using the top or bottom chord, the linear chain may be formed of the web members of a truss (Fig. 8; see also Fig. 3). This procedure is sometimes used because it appears more expeditious than the others; the angle changes are more easily computed, each being derived from a single triangle; and the solution gives the deflections of all the panel points instead of those of a single chord. The disadvantage of this method, however, lies in the necessity of making a special correction for the line changes in the web members, unless it is decided to neglect such correction.

The angle changes determined for the truss in Fig. 8 are plotted in a force polygon, Fig. 9, and the corresponding funicular polygon, drawn below the truss, represents the desired deflection diagram (Fig. 10).

Correction for Line Changes

The above method gives the deflections caused by the angular deformations (angle changes) between the members of the chain. To these deflections must be added those produced by the pure elongations (line changes) of the members in the chain. In Fig. 7 the effect of the line changes upon the vertical deflections is zero, as all of the members are horizontal. In the systems of Fig. 8, however, the effect of the linear deformations is considerable and a special correction must therefore be applied to the results of the above procedure. This is a point which has been overlooked by some writers, although the resulting error in the deflections may amount to 15 per cent.

The correction may be made graphically as follows: A simple Williot diagram, Fig. 11, is constructed by the vector addition of the elongations of the members, but with the resulting rotations omitted since these are already included in the effect of the angle changes. To this diagram is attached a small reproduction of the structure to provide for the rotation of the system back to its horizontally constraining abutment, a correction which is not required when the strains are symmetrical. The vertical deflections of the different panel points are then scaled from the resulting diagram and added to the values of the deflections determined from the angle changes. This correction is shown graphically in Fig. 10.

If the line changes are symmetrical, the correction to the deflection at any panel point is given analytically by

$$\delta' = \Sigma\,\Delta s.\sin\alpha = \frac{1}{E}\Sigma\,u.v \qquad (8)$$

where u is the intensity of stress and v is the vertical projection of each member, and where the summation extends from either end of the span to the panel point. If the line changes are not symmetrical, eq. (8) will give a different result for each segment of the span; the true value will lie between these and may be obtained by interpolation in the inverse ratio of the lengths of the segments.

(*To be concluded*)

United States Begins to Produce Potash

Potash salts were produced in the United States in 1915 to the value of $342,000, according to the U. S. Geological Survey. Though this figure is of interest as showing a small beginning in the domestic potash industry, it is of little importance if the total need to the country is considered, for it represents a quantity consumed in less than a week under normal conditions. Experimental work on the production of potash salts was active during the year, and, in places, the activity has been succeeded by the construction of plants. Manufacturers of Portland cement, having had their attention directed to a possible revenue from byproduct potash, are investigating their raw materials.

Test of Mushroom Flat Slab in Seattle Warehouse Shows High Local Stresses

Official Investigation of Building by Extensometer Measurements Under Live Loads Carried to 1.1 Times the Design Load

By D. E. HOOKER
Assistant Superintendent of Buildings, City of Seattle

RESULTS of extensometer measurements of the strains in steel and concrete of a mushroom flat-slab floor recently reported to the building department of Seattle, Wash., show high local stresses near the columns in both steel and concrete, with many cracks in the latter at a maximum test load equal to 1.1 times the design loading. Permanent sets were indicated by the measurements, and the final deflection after the removal of all load was a large percentage of the maximum deflection under load.

In August, 1913, the present Seattle building ordinance became effective. It is stated in the ordinance that the regulations pertaining to reinforced-concrete work "are based upon tests of the ordinary monolithic types of reinforced concrete, consisting of slabs, beams, girders and columns. But it is not intended to exclude other types of reinforced-concrete construction which meet the requirements of safety contained in this code, subject to the approval of the superintendent of buildings." It is provided that the superintendent of buildings may require tests to determinne the sufficiency of any proposed system or type of construction.

In view of the foregoing provisions of the ordinance, C. A. P. Turner, in the latter part of 1914, applied to the building department for approval of the mushroom system of construction. Before a decision in the matter had been reached, the Port of Seattle Commission filed an application for a permit to construct a large warehouse and office building of mushroom flat-slab construction. After considerable delay the superintendent of buildings, T. Josenhans, consented to issue the permit, with the understanding that an extensometer test of the building would be made to determine "the strength and sufficiency of the mushroom slab for the purpose of enabling the building department to secure its own data for the treatment of subsequent applications for mushroom constructions."

The test subsequently made after completion of the building was conducted for the building department by Dean Almon H. Fuller and Prof. Charles C. More of the college of engineering of the University of Washington. The data hereinafter set forth are taken from their report to the superintendent of buildings.

Location of Test Panels

The building, ordinarily referred to as the Bell Street Warehouse, is approximately 80 x 435 ft., 60 ft. high. The warm storage portion, in which the test area was selected, consists of four stories. The test area comprised four contiguous panels on the third floor, including two wall panels.

The floor was designed for a live load of 500 lb. per square foot, and a dead load of 144 lb. per square foot, including the ¾-in. top finish. The mean actual thickness of the rough slab measured on approximately 5-ft. sections was 10.98 in., the design thickness being 10¾ in.

The location and construction of the tested panels and the position of the load are shown on Figs. 1 and 2. The loading material was sheet tin in wooden boxes. Three sets of measurements were taken, after average uniform loadings of 265, 470 and 700 lb. per square foot had been applied in three increments.

Tapered Plugs Used

After the reinforcing steel of the slab had been placed and made ready for the pouring of the concrete, tapered wooden plugs were fastened to the steel, to be removed after pouring, leaving holes by which access to the steel could be had without undue chipping of the slab. An accompanying photograph shows some of these inserts in place.

The gage-line holes were drilled with a No. 54 drill. For the concrete gage lines little steel plugs were set into the concrete with plaster of paris, and the holes drilled in these plugs. The readings on these were more erratic than were those on the reinforcing rods; some of the plugs, in fact, became loosened and had to be discarded. Readings were taken with Berry strain gages, the lengths of all gage lines being 8 in.

SLAB AT COLUMN 79 BEFORE TESTING

Measured Stresses

The position of the gage lines, with the stresses at each due to the three increments of live load, as computed from the observed deformations according to the assumptions hereafter set forth, are shown on Figs. 1 and 2, in which compression in steel and tension in concrete are shown as negative quantities. The stresses shown were computed from the averages of deformations measured in most cases by three observers. The first quantity shown at each gage line is the stress occasioned by the first average live load of 265 lb. per square foot, the second quantity is that occasioned by the average load of 470 lb., and the third is the initial stress caused by the final test load of 700 lb. It should be borne in mind that the stresses and deformations herein mentioned or shown, unless otherwise noted, are those occasioned by the live load alone.

WOODEN INSERTS USED AT STEEL RODS

The slab was poured Dec. 16, 1914, in a temperature just about at freezing. The water used in mixing the concrete was heated. For several days after the slab was poured the temperature hovered around the freezing point, although there is no evidence that the concrete was touched by frost.

Placing the Test Loads

The first increment of the test load was placed on April 8, 1915, when the slab was 113 days old. The first, second and third increments of load were placed at intervals of 24 hr. Readings were taken just after the placing of each increment; also 24 hr. and again 84 hr. after the third increment was placed. After this the third increment was removed from the two wall panels and all three increments from the two interior panels, the removal occupying some three days. Readings were then taken with the 470-lb. load only in place on the two wall panels, the two interior panels being empty. The remaining load was then removed, after which two sets of readings were taken, 48 hr. apart.

The maximum stresses shown in Figs. 1 and 2 were computed from the deformations observed in the first series of readings taken after the placing of the last increment of the test load. Almost without exception the deformations at all points increased during the 84 hr. that the total load remained in place. The average increase was about 18 per cent.

Permanent Sets

After all the load was removed from the interior panels, and the third increment from the wall panels, the slab of the two inside panels recovered materially, the deformations decreasing an average of about 53 per cent of the maxima. The decrease in the deformations for the wall panels averaged about 14 per cent. The last readings taken, two days or more after removal of all load, showed an average decrease from the maximum deformations of about 58 per cent for both the wall panels and the interior panels.

Deflection readings were taken with an engineer's level; also by direct measurements between the loaded slab and the one below it, and the results are shown graphically on Fig. 3. They show a maximum deflection of 0.8 in. in the center of the north wall panel, and a permanent set at this point of 0.38 in.

The concrete of the slabs and columns was a 1:2:4 mix, the coarse aggregate being gravel. A number of 8-in. test cylinders from 12 to 16 in. long were cast during the pouring of several of the slabs and allowed to cure in and about the building. Tests of these and of several specimens cut out of the tested floor slab after removal of the load showed an ultimate strength of from 1730 to 3470 lb. per square inch. The average strength of five cylinders and two slab specimens was 2230 lb. per square inch.

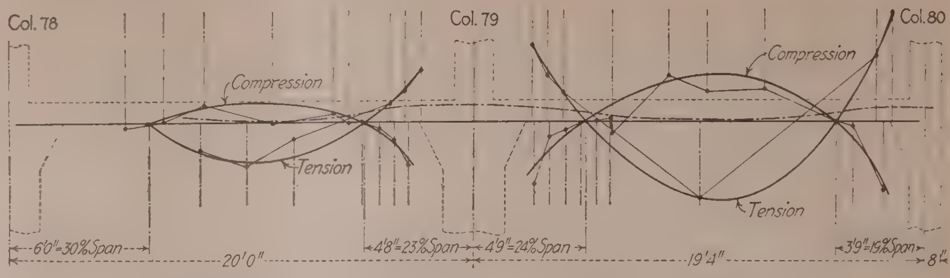


FIG. 4—APPROXIMATE STRESS CURVES ON LINE BETWEEN COLUMNS 78, 79, 80

TEST VALUES FOR MODULI OF ELASTICITY ARE USED

Measurements of deformation of two cylinders and one slab specimen, under load applied at a similar time rate as the test load, led to the conclusion that the modulus of elasticity of the concrete could fairly, for the purpose of computing stresses from the initial deformations observed after the placing of each increment of load, be assumed to be 2,500,000 lb. per square inch. This modulus has been used in computing the stresses shown in Figs. 1 and 2. On this assumption a deformation of one dial unit of 0.0002 is equivalent to a stress of 62.5 lb. per square inch.

Experiments were made as quickly as possible after completion of the test to determine the moisture content, absorption and specific gravity of the concrete. These showed that the concrete specimens cut out of the slab had a moisture content of about 7.5 per cent, as compared with 5 per cent for the test cylinders; a saturation of 9.5 per cent as compared with 7.6 per cent for the cylinders, and a specific gravity of 2.13 as compared with 2.23 for the cylinders.

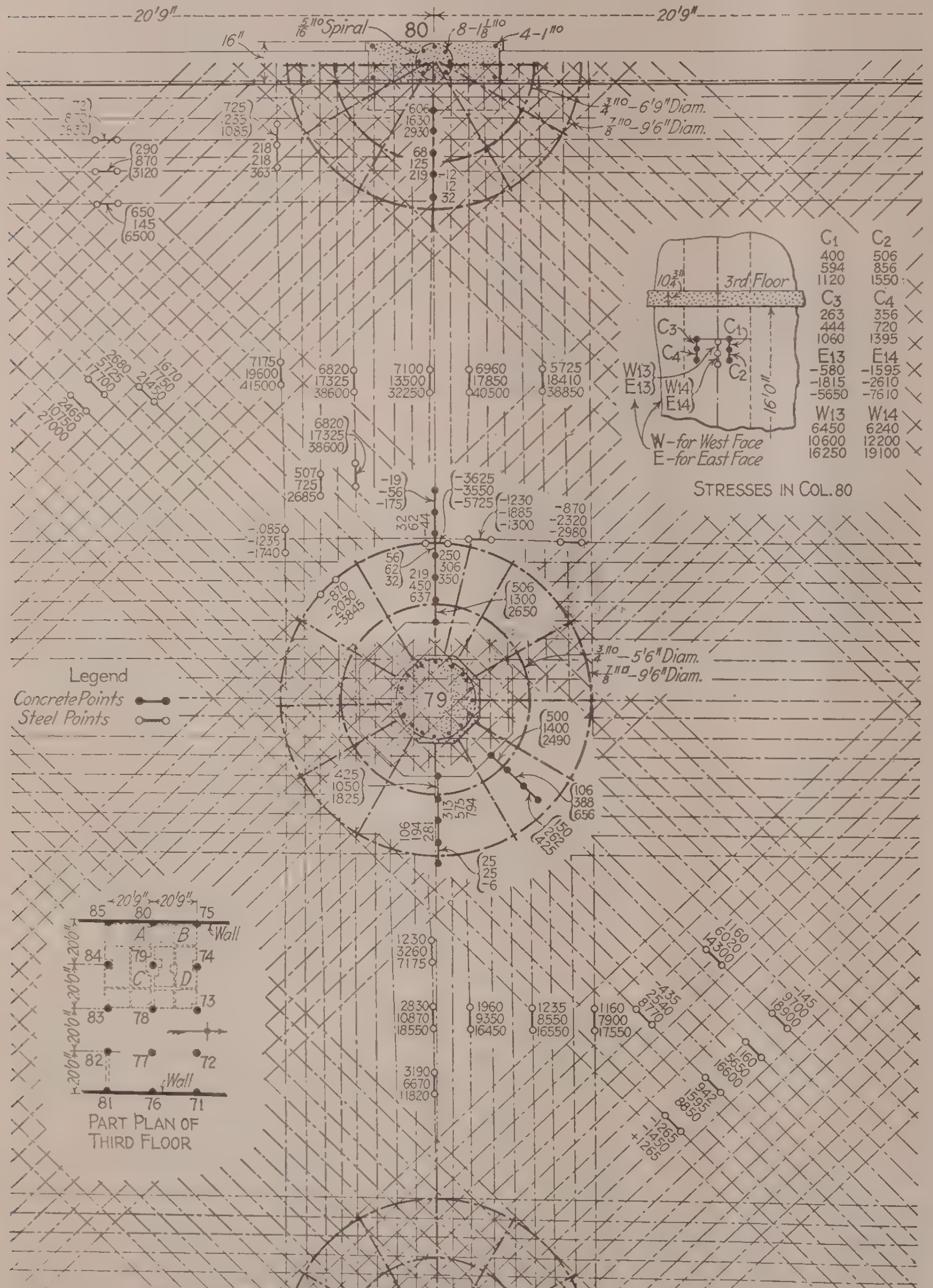


FIG. 1—STRESSES IN UNDERSIDE OF SLAB AND IN WALL COLUMN 80

Note the high concrete stresses near the column heads.

The steel used was of hard, re-rolled grade, plain round rods, with an ultimate strength of about 90,000 lb. per square inch and an elastic limit of about 50,000. The modulus of elasticity assumed from test results was 29,000,000 lb. per square inch. Hence a dial unit of deformation is equivalent to a stress of 725 lb. per square inch.

INTERPRETATION OF RESULTS

Certain outstanding features are pointed out in the official report of the test substantially as given in the following paragraphs:

The greatest deformation observed in the steel was for the point near wall column 80 on the center rod between columns 79 and 80. This, for the third day of the third increment, was 0.0140 in. This indicates a stress of 50800 lb. per square inch in the upper fibers of the rod. It is barely possible, though not probable, that the elastic limit had been reached and the actual stress was somewhat less. But it must have been in the neighborhood of 50,000 lb. per square inch.

(It should be noted that the foregoing stress was induced by the live load alone, which amounted to 1.1 times the combined design live and dead load. The foregoing live-load stress would indicate that the total stress in the rod, due to dead and live loads combined, approached 61,000 lb. per square inch.)

UNIFORM STRESSES IN STEEL BANDS

It is interesting to note the fairly uniform distribution of stress, exceeding 44,000 lb. per square inch, in points across the band of steel in the wall panel between columns 79 and 80, and to compare it with the 21,000 lb. as an average of the stresses at points across the same band in the interior panel between columns 78 and 79. There is further interest in noting that under the second increment of load (slightly less than the design live load) the comparative figures are approximately 18,000 and 9,000. The distribution in both places is more nearly uniform under the greater loads.

The center rod carries a greater stress than the others in the interior panel and a lesser one in the wall panel. As this rod was directly under an aisle, it seems natural that it should be somewhat relieved. The survey of the steel shows this rod to be misplaced in the wall panel and over column 79. This may account in part for the apparent discrepancy, and also possibly

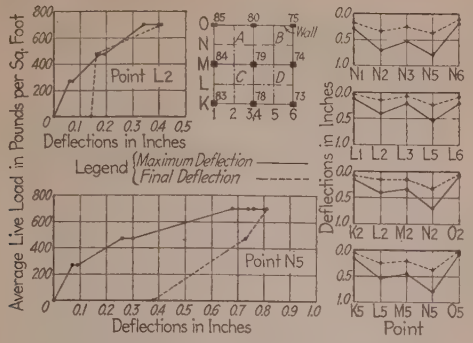


FIG. 3—INITIAL AND FINAL DEFLECTIONS

for a portion of the excessive stress at the point near wall column 80.

PROBABLE POINTS OF CONTRAFLEXURE

On Fig. 4 are plotted the stresses found at those gage lines on the center line through columns 78, 79 and 80, locating the probable points of contraflexure. These stresses are computed from the initial deformations observed after placing the third increment of load.

Lower steel deformations show the maximum stress in the northeast-southwest diagonal bands to be about the same as in the east-west bands in the interior panels. The stress in the diagonal bands was less than in the east-west bands in the wall panel; the stress in these bands, however, is greater in the wall than in the interior panels. The deformations are small in the rods parallel to the wall.

STRESSES IN THE RADIAL AND RING RODS

The upper fibers of the radial rods were subjected to tensile stresses from 16,000 to 22,000 and the inner ring rods to tensile stresses from 16,000 to 19,000 lb. per square inch. The outer ring rods were found to be in compression by about 5000 to 6000 lb. per square inch.

STRESSES IN WALL COLUMN 80

Steel deformations on the east and the west sides of wall column 80 were the most difficult to read and the results are, perhaps, the least precise of any. However, there is a tendency that is unquestionable for a good, strong, live-load tension of approximately 20,000 lb. per square inch in the west or outside rods, and a live-load compression on the inside rods of perhaps one-third as great. In both cases the stresses in the upper points, directly below the bracket, were smaller than in the ones immediately below. Concrete deformations directly below the bracket were measured, and the two lower points again showed the greater stresses—probably 1300 and 1200 lb. per square inch respectively. The upper points were doubtless stressed at least 1100 lb. per square inch.

LOAD ON WALL PANELS ONLY

It may be noted that the stresses in the wall panel and in wall column 80 are very nearly equal for the uniform load of 470 lb. on the wall panels only, and for the full load of 700 lb. on the four panels under test, and that they are far greater than for the 470-lb. load on the four panels. The precision in the above statement is not as great as the deformations would indicate, on account of the continued deformations under load and the set in the concrete.

It seems probable that the matter of unloading; that is, removing the third increment from the wall panels first, favored the wall panels somewhat, and that a full live load on wall panels would produce stresses in portions of those panels very nearly as great as one-and-a-half live load uniformly distributed over the entire floor.

CONCRETE CRACKS

A number of hair cracks were visible under the second increment of load. These were: (1) Several on the underside of the wall panels parallel to the wall; (2) one on the top of the slab near the wall and parallel to it, one around column 79 at approximately the outside of the bracket, and one along the center line of columns 78, 79 and 80 for the greater portion of the distance; (3) across the outside of wall column 80 at about the elevation of the bottom of the bracket.

The third increment of load enlarged the ones on top of floor and on wall column and developed another for a portion of the distance from columns 74, 79 and 84 and others around columns 79 and 80. This increment greatly increased the number on the lower side of the slab and extended the distribution.

A few cracks developed perpendicular to the wall through the greater portion of the central third of panel *C* and extending to about the center of panel *A*. Likewise through panel *D* and into *B*. No cracks were discovered through the interior panels *C* and *D* parallel to the wall.

The building was designed for the Port of Seattle Commission by Capt. A. O. Powell of Seattle, and C. A. P. Turner of Minneapolis. It was constructed by the Pearson Construction Company of Seattle under the superintendence of the engineering department of the Port Commission.

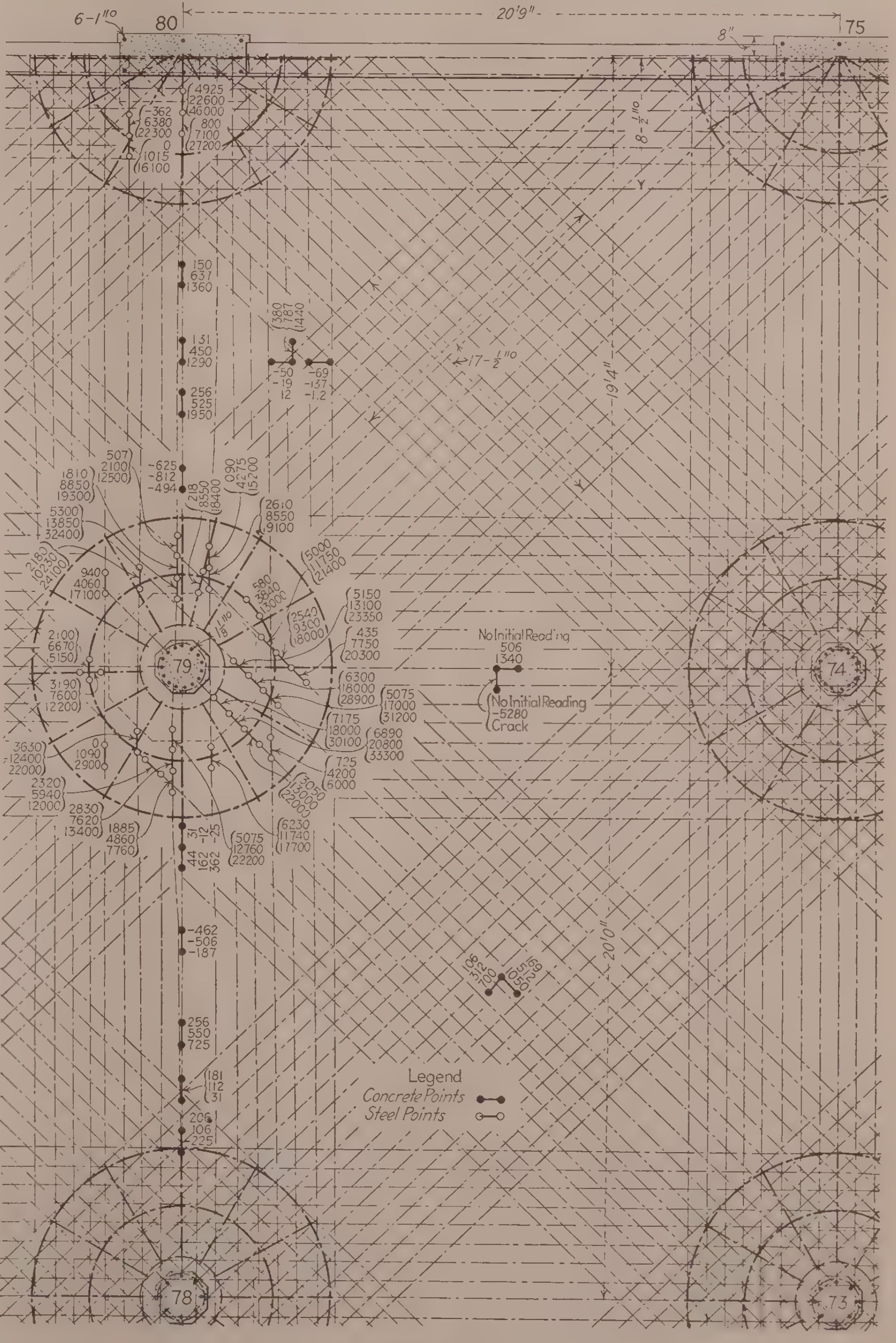


FIG. 2—STRESSES IN TOP OF SLAB SHOW HIGH VALUES IN STEEL

Literature

For the Civil Engineer and Contractor

New Publications

Building Code—City of New York. Paper, 4½ x 7½ in.; 278 pages. New York, Bureau of Buildings, Municipal Building.

The Practical Design of Steel-Framed Sheds. By Albert S. Spencer. Cloth, 6 x 10 in.; 163 pages; illustrated. New York, D. Van Nostrand Company. $3.50 net.

Journal of the Western Society of Engineers, Vol. 20, No. 10. Index to Volumes 1-20. Paper, 6 x 9 in.; 89 pages. Chicago, published by the Society, 1735 Monadnock Block.

Power Possibilities on the Raquette River. Report of New York State Conservation Commission. Paper, 6 x 9 in.; 112 pages; illustrated. Albany, State of New York Conservation Commission.

Irrigation Management. By Frederick Haynes Newell, professor of civil engineering, University of Illinois. Cloth, 5 x 7½ in.; 306 pages: illustrated. New York and London, D. Appleton & Company. $2 net.

Masonry Dam Design. By Charles E. Morrison, C. E., Ph.D., and Orrin L. Brodie, C. E. Second edition, revised and enlarged. Cloth, 6 x 9 in.; 276 pages; illustrated. New York, John Wiley & Sons, Inc. $2.50 net.

Military Preparedness and the Engineer. By Ernest F. Robinson, Captain, Corps of Engineers, National Guard of New York. Cloth, 4¼ x 6¾ in.; 224 pages; illustrated. New York, Clark Book Company, Inc. $1.50 net.

Design of Intakes, Scroll Cases and Turbine Draft Tubes for Single-Runner Turbines. By A. G. Hillberg, hydraulic engineer. Paper, 11 x 14 in.; 11 pages, illustrated. Reprinted from the Engineering Record. Copies may be obtained from the author, Park Row Building, New York.

Relation of Mineral Composition and Rock Structure to the Physical Properties of Road Materials. By E. C. E. Lord, petrographer. Bulletin 348, U. S. Department of Agriculture, Office of Public Roads. Paper, 6 x 9 in.; 26 pages; illustrated. Washington, Government Printing Office.

Road Dust Preventives—References to Books and Magazine Articles. Paper, 6 x 9 in.; 39 pages. Pittsburgh, Carnegie Library.

List representing part of the more recent literature on this subject, including general biography, non-bituminous and bituminous materials, hygienic aspects and American and foreign practice.

Street-Name Signs. By Roland S. Wallis. Bulletin 20, Engineering Extension Department Technical Service, Iowa State College. Paper, 6 x 9 in.; 47 pages; illustrated. Ames, Iowa, Iowa State College.

A profusely illustrated booklet giving many examples of good and bad methods of designating streets at street intersections. General requirements, legibility, size and style of lettering, color combinations, number and location of signs, illuminated signs, durability and cost are all treated concisely, and details of supporting devices shown.

Parks and Park Engineering. By William T. Lyle, professor of municipal engineering, Lafayette College. Cloth, 6 x 9 in.; 130 pages; illustrated. New York, John Wiley & Sons, Inc. $1.25 net.

The first book to deal with engineering features of park construction. While many of the problems which relate to park engineering, such as road construction, underdrainage and sewers are treated in various books, this text treats them in their specific relations to park construction. The chapter on labor and contracts should be especially useful to city officials.

Theory of Errors and Least Squares. A textbook for college students and research workers. By LeRoy D. Weld, M. S.; professor of physics in Coe College. Cloth, 5 x 7½ in.; 190 pages; illustrated. New York, Macmillan Company. $1.25 net.

This book is written with a special purpose—to make so clear through simple and concise treatment the subjects of precision and the distribution of errors by the theory of least squares that not only students but any research worker may quickly become master of the methods presented. Examples are given, illustrating applications to various branches of science, including surveying and astronomy.

Invar and Related Nickel Steels. Circular 58, U. S. Bureau of Standards. Paper, 7 x 10 in.; 68 pages; illustrated. Washington, Government Printing Office.

Describes some of the more important properties of nickel steels in general, with particular reference to invar, and consists largely of a compilation of results obtained by various investigators during the last twenty-five years. Treats reversible and irreversible nickel steels magnetic properties, electrical properties, thermal expansion, constancy of dimensions of invar, density, mechanical properties, resistance to corrosion, applications and sources of supply. Much of the treatment is from the metallurgical point of view.

Books Reviewed

The Strength of Materials

Author, Ewart S. Andrews, lecturer in the engineering department of the Goldsmiths' College, New Cross, and at the Westminster Technical Institute. Cloth, 5½ x 8½ in.; 604 pages, 264 illustrations. New York, D. Van Nostrand Company. $4 net.

Reviewed by Melvin L. Enger

Assistant Professor of Mechanics and Hydraulics, University of Illinois

This is an advanced book on the mechanics of materials written for students preparing to take examinations for associate member of the Institution of Civil Engineers in Great Britain, and for the university degree in engineering.

The text begins with a chapter on stress, strain and elasticity containing an unusually clear presentation of the effects of combined loadings. Then follows a chapter on the behavior of materials under test in which the Rankine, St. Venant, Guest and Navier theories for conditions causing failure are developed and discussed. Then follow discussions of reptition of stress, working stresses, riveted joints and thin pipes.

In the treatment of beams both analytical and graphical methods are given, with considerable attention devoted to concrete and reinforced concrete. In the discussion of columns the author uses the "buckling factor," which is defined as the length of the equivalent pin-ended column divided by the least radius of gyration, instead of the slenderness ratio. The treatment of concrete columns cannot be considered complete.

The usual treatment of torsion of shafts is given, and St. Venant's approximate formulas for non-circular shafts are stated. The subject of springs is unusually well presented. There are two chapters on the testing of materials, in which various types of testing machines and extensometers are described and illustrated. Flat plates and slabs are treated by the Bach and by the Grashof-Rankine theories, and the results of the Grashof theory for circular plates are given in tabular form.

Thick pipes are treated by Lamé's theory, and formulas for the required thickness are deduced on the maximum-stress theory and on the maximum-strain theory. Excellent chapters on curved beams and on rotating drums, disks and shafts complete the text. A good set of problems, with answers, is included, and the properties of the British standard sections, together with some mathematical tables, are given in the appendix.

The long ton is generally used as the unit of force. The mechanical make-up of the book is excellent, although the lettering in some of the figures is poorly done. Many tables, curves and charts have been included for the use of designers, and their use is made clear by the solutions of illustrative problems. The book will take a high rank in the literature of the mechanics of materials.

Pole and Tower Lines

Author, R. D. Coombs. Cloth, 6 x 9 in.; 272 pages, 162 illustrations and diagrams. New York, McGraw-Hill Book Company. $2.50.

Reviewed by A. G. Hillberg

Civil and Hydraulic Engineer, New York City

The author of this book should be complimented upon his work. Electric transmission of power is one of the most important branches of engineering. It has a direct bearing on the industrial development and, consequently, the prosperity of a nation. However, so far only the electrical problems entering into such construction have received careful attention, and while several good books are available, not until the publishing of this book has the purely structural side received due attention. Generally the supports of transmission wires have been spaced in an offhand fashion, and thus in many cases so closely that neither they nor the conductors have been loaded up to their permissible unit stresses.

The subject has been divided into fourteen chapters, namely: Types of Construction; Loading; Wires and Cables; Design; Wooden Poles; Steel Poles and Towers; Special Structures; Concrete Poles; Foundations; Protective Coatings; Line Material; Erection and Costs; Protection, and Specifications.

In these chapters the various phases of the problem have been discussed clearly, and where necessary diagrams and tables have been inserted. The illustrations, of which the majority is halftones, show both American and foreign practice. Of special value are the chapter dealing with erection and costs, and the specifications contained in the last chapter and elsewhere in the text.

Industrial Leadership

Author, H. L. Gantt. Cloth, 5 x 7½ in.; 128 pages. New Haven, Yale University Press. $1 net.

This little volume is composed of addresses delivered in the Page Lecture Series, during 1915, before the Senior class of the Sheffield Scientific School, Yale University. The first of the addresses, bearing the same title as that of the volume itself, is most inspiring and will repay reading again and again. Mr. Gantt contends that to bring the United States to the position it should occupy in the industrial life of the world we must develop great leaders. Throughout the addresses are found pregnant thoughts such as these:

"The authority to issue an order involves the responsibility to see that it is properly executed."

"In a civilized country we are all buying and selling service. The bread we eat, and the coal we burn are available to us through the service of many people. Likewise our value to the community is measured by the service we render, and in the long run our reward is apt to be in proportion to that service."

"People learn but little from what they are told, but they readily imitate what appeals to them. If, therefore, a man would be a leader he must know thoroughly the people whom he would lead and be able to shape his actions in such a manner that they will not only be understood but thoroughly appreciated by his followers."

The remaining chapters are on the training of workmen, principles of task work, results of task work, and on production and sales. In these chapters there is much that has been gone over at various times since the scientific management movement gathered force. Mr. Gantt's statement, however, is lucid and brief and will interest those who have not closely followed this important subject. The chapter on production and sales contains some unusually interesting sale-price curves.

City Planning

Author, Charles Mulford Robinson. Cloth, 6 x 9 in.; 344 pages, 64 illustrations. New York, G. P. Putnam's Sons. $2.50.

REVIEWED BY MORRIS KNOWLES
Consulting Engineer, Pittsburgh, Pa.

In this volume the author has elaborated and made additions to his book, "The Width and Arrangement of Streets," published in 1911, and has thus produced a book of much usefulness to beginners in the subjects of engineering, economics and sociology, all of which enter into the study of city planning. While he devotes his attention entirely to thoroughfares and street areas, the author properly points out that they constitute the skeleton of the city, comprise from 25 to 45 per cent of its total area, and thus contribute a substantial part of the total investment and maintenance cost. The book, which is descriptive of what has been done and what can be done, does not assume or demand a technical knowledge of any of the fundamental sciences underlying the subject, but in a general way shows the scope and general trend of town planning, and of municipal development along the lines of logical arrangement, rather than unregulated or arbitrary allotments.

The author shows briefly the need of town planning by explaining how growth and development have demanded regulation and then how regulation has led to standardization—an illogical, arbitrary, extravagant and inconvenient system. Having shown the defects of standardization, both from the social and economic points of view, he offers functional or logical plotting, which the reader is by that time quite prepared to accept. The author has made his strongest appeal for this an economic one, doubtless because American judgment is usually most easily appealed to in terms of dollars and cents. At the same time the ends for which he is striving are more social than economic, and town planning is shown to be desirable that people may live more comfortably and healthfully, and travel more conveniently.

The main plotting of the arterial system, which must be laid out to take care of traffic, is in itself more a matter of convenience than of economy. Such a system must be designed not only to care for traffic, but also to be adjacent to and easily accessible from the residential sections, which must be carefully located and planned with regard to the health, convenience and comfort of the community.

In residential sections, economy by the use of narrow streets and by avoiding cuts and fills through following the contours is most effectively urged. But here, too, such saving is really most desirable because of its effect on rents in the poorer sections, and because in the higher-class sections it attains at the same time increased beauty, individuality and comfort. Many of the departures from standardization which are offered are extremely useful, and most of them have been successfully applied in almost every city. Scarcely a city with natural topographical features can be found that has not made use, at least in isolated cases, of some of these suggestions, such as grading sidewalk and road to different levels, omitting sidewalks on one or both sides of the street, two-level streets, and use of narrow lanes or walks where no driveway is essential.

A prima facie case is made out for foresight in planning for open spaces and reservations for schools, public buildings and playgrounds, and every engineer or business man, accustomed to plan for future development, will readily acquiesce in the author's condemnation of the extravagant expenditures so often required in this country to provide public buildings, park spaces and schools at later periods in the history of a city.

The author summarizes in the last section the development of legislation, ordinances and by-laws relating to town planning, and in his appendix gives examples of model laws for carrying out town-planning schemes. The index is ample, the illustrations are plentiful, and the mechanical arrangement of the book is convenient for reference.

Unless a word of caution be said, there is danger that so excellent a book may mislead city-planning bodies into the error of supposing that they can, with its aid, work out all the problems that come before them. It is unfortunate, therefore, that the author, although stating that "the book is presented with no illusion as to its providing a panacea," has not laid more stress upon the fact that town planning is, in the last analysis, the work of the expert. It is for the student, the trained town-planning engineer, to work out these problems of plotting and arrangement, and grievous mistakes will be made by commissions, no matter how sincere and public-spirited they may be, unless they have the benefit of expert advice based upon broad experience and adequate investigation and study.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Shall the American Society of Civil Engineers Move Its Headquarters?

SIR: The discussions of the proposed change of the headquarters of the American Society of Civil Engineers to the Engineering Societies' Building on Thirty-ninth Street show a strong sentiment in favor of the "get together" movement, but there seems to be some apprehension lest the society should lose its individuality.

With the present income of the American Society of Civil Engineers and the prospect of still future large increase, would it not be practicable for it to finance a new building of its own on Fortieth Street—next door to the Engineers' Club—and by a proper connection to the Engineering Societies' Building form a suitable entrance facing Bryant Park, on Fortieth Street, for the entire joint building?

This seems very much needed.

New York. HENRY B. SEAMAN.

Architect vs. Engineer

SIR: The undersigned, as a member of the New York State Board for Registration of Architects and also as one of the directors of the American Institute of Architects, was much interested in an article which appeared in the Engineering Record of March 25, page 406.

I am pleased to see the suggestion of co-operation as between engineers and architects. Surely nothing but a misunderstanding could cause a breach between the professions, and there is every reason for friendly relations. It will be my pleasure to bring before the Board of Directors of the Institute at our next meeting the suggestion that a committee be authorized to confer with some corresponding committee of engineers on this subject.

Will you permit me in the meantime to call the attention of engineers not already informed that the New York law for the registration of architects does not interfere with the right of an engineer or a builder to design or supervise or erect any building? The law is designed to raise the standard of education of architects and is expected to accomplish its purpose in the course of years by requiring all who wish to use the title "architect" to comply with certain requirements as to education, ability and experience.

It is presumable as a premise that the engineering profession does not approve of any person without training or experience arbitrarily taking to himself the title of "engineer," and thereby helping to lower the profession in the respect of the public.

The architectural profession feels very keenly our need of higher average standards of qualifications. Surely our two professions should co-operate to attain greater usefulness which will be a legitimate benefit to the profession so long as it also operates to prevent imposition upon the public.

D. EVERETT WAID,
President State Board of Registration of Architects.
Albany, N. Y.

Keeps an Up-to-Date and Convenient Scrap Book

SIR: At first I used to save and bind all of the numbers of the Record and index the articles that were especially interesting to me with a card system. The heavy bound volumes became bothersome and I found that I was not referring to them at all. I stopped saving and binding the Engineering Record and for a while depended altogether on the nearest public library for my reference to it. This did not meet with my needs satisfactorily and then I started the following system, which I have kept up for ten years:

I cut out the pages, close to the binding, which contain any article which I feel I would want to save and put these pages in a certain drawer of my desk. If the article is the first one of a series you usually indicate it by a special design on the cover so I save that number and bind in it all of the following articles of the series. I cut out all of the pages not used in this number for the article, cutting on the margine line so as to leave a lot of stubs. Then I paste the cut pages with the other articles to these stubs in the order of their issue, giving me a number of books, all of one size, containing only certain information and always easy to haul out and look over.

I have the series of articles on the first Quebec Bridge; another on the Blackwells Island Bridge; one on various viaduct bridges; a story about Arch Bridges; another on the microscope and concrete, by Nathan Johnson, and I am starting one now on National Defense. I have in mind saving most of the articles you publish on bridge erection, dividing them up into groups of cantilever, suspension, and ordinary.

This system requires no indexing and only a little time now and then with a paste pot and a knife. And I dare say the entire lot of articles I have saved do not pile up higher than three inches, and I look them over often.

WALTER J. PARSONS.

Flushing, L. I.

What Causes Peculiar Refraction on Arizona Desert?

SIR: In answer to a letter on Arizona desert refraction from Thomas A. Hayden in the Engineering Record of March 25, page 427, I beg to say a few words. While the writer is not personally acquainted with the special conditions existing in Arizona, and therefore cannot give an answer to the question "What causes the peculiar refraction on Arizona deserts?" he knows of a method to eliminate the influence of refraction in stadia measurements. This method, which gave accurate results under all meteorological conditions occurring during a year, would be worth a trial in Arizona.

It is a well-known fact that refraction affects the accuracy of stadia measurements by changing the length of the rod intercept. The effect of refraction is much greater near the ground than it is a few feet above. The lower line of sight passing through the layer near the ground is refracted differently from the upper line of sight traversing the upper strata. This causes the rod reading to differ from what it would have been had the air been homogeneous. If both lines of sight should traverse the same strata there would most likely be no effect from refraction.

The writer, while connected with the Royal Technische Hochschule at Danzig, Germany, carried out a one year's test of the influence of this "differential refraction" on the accuracy of stadia measurements. In the course of these studies he also used a horizontal rod instead of a vertical rod for taking rod readings. The rod was brought perpendicular to the line of sight by means of a diopter, a special rod support being provided. Even on days when the influence of refraction was very noticeable with a vertical rod, measurements taken with the horizontal rod gave accurate results. For surveying with the horizontal rod the diaphragm carrying the stadia hairs has to be turned 90 deg.

Though the influence of differential refraction is naturally less in localities with moderate climate and covered with vegetation than in the desert region of Arizona, the application of the horizontal rod will most likely permit the use of the stadia method with good results. This would outweigh the little inconvenience which the use of the horizontal rod involves.

DR. KARL G. HABERMEHL.

Hoboken, N. J.

Measuring Flow in Concrete

SIR: I note your editorial in the issue of March 4, page 310, on the flow of concrete and the conclusions to be drawn from extensometer measurements in tests. To one who has had a fairly comprehensive experience with construction, it is astounding to observe how many engineers and embryo investigators from our universities are firmly convinced that 60 to 90 days in cool, chilly weather thoroughly hardens the concrete and that at the end of so many days they can actually determine the stresses in a floor which is half cured by measuring the deformation of the concrete and reducing this deformation to stress on the basis of instantaneous, or nearly instantaneous, measurements on cylindrical specimens of the same mix, but cured in a manner which enables them to dry out and be two or three times as rigid as the material in the floor on which measurements were taken.

Extensometer tests should add greatly to the sum of engineering knowledge. But this requires the exercise of thought and care on the part of those who conduct such tests, otherwise much misinformation will be extracted therefrom.

The time to take measurements on the concrete in testing a floor to determine the concrete stress is evidently during the removal and not during the application of the load. When a floor is cast, shrinkage of the concrete occurs during hardening in the air. Consequently, before initial loading the floor is in condition of internal strain due to shrinkage during hardening and the deformation under the initial load is the sum of these internal stresses and those produced by the load and not the result of the application of the load alone. The stress, if it exists, will manifest itself in the recovery of the slab while the load is being removed, and if the deformations are measured during this period of the test, *i. e.*, taking the condition as zero when the load is fully applied and noting the change in deformation until the load is half removed, we then have a basis on which we can determine the stress with errors largely eliminated.

This is a matter which should be called to the attention of those building inspectors who insist on considering that deformations of the concrete under initial loading are a real criterion of the state of stress. Many times they are 100 per cent in error through taking this illogical position. That is, they consider the stress to be 100 per cent more than that which really exists.

For example, if we consider the tests of Messrs. Fuller and More (see page 279 of the issue of Feb. 26), in some cases it would appear that recovery was about 0.4 of the total deformation. To assume that the deformation where there is less than 40 per cent recovery can be translated into elastic stress without considering the permanent set and lack of recovery represents the absurd position taken by many. No one would be willing to assume where there is no further recovery after application of the load and the material is free to recover that there is any material elastic stress operating in that direction.

C. A. P. TURNER,
Consulting Engineer.

Minneapolis.

[Because of his extensive experience in testing concrete by such strain measurements as are here discussed, a copy of Mr. Turner's letter was sent to Prof. Herbert F. Moore, of the University of Illinois, and he was asked to comment upon it. His reply follows.—Editor.]

SIR: With the second paragraph of Mr. Turner's communication, "Extensometer tests should add. . . . Otherwise much misinformation will be extracted therefrom," I am in thorough agreement. It is a general statement, but one which should be frequently made and emphasized.

I am not of the opinion that determinations of elastic stress in a material like concrete should be made wholly from readings during the release of load on a test slab or building floor. Frequently in applying load very small cracks open in the concrete, on the release of the load the jagged edges of these microscopic cracks do not close perfectly, and there are left in the concrete stresses which are not shown by readings during release of load alone. It seems to me that extensometer readings should be taken both during application of load and during release of load, and both sets of readings considered in estimating stresses.

It has been my observation that in estimating stresses in a test floor or slab that much more confidence is placed (and rightly placed) on stress determination in steel reinforcement than on stress determination in concrete, and I believe that there are few building inspectors who "insist on considering that deformations of the concrete under initial loading are a real criterion of the state of stress." In estimating the stresses in the steel, reliance on readings obtained during release of load alone would render practically impossible the observation of any stress in the steel beyond the yield point. Of course, such stress should not exist in a well-designed floor under working load, but tests should be of such a nature as to detect such a state if it does exist.

In strain readings on steel, as in strain readings on concrete, I am of the opinion that readings should be taken both during application of load and during release of load, together with an examination of the surface of the test floor or slab for cracks, and that all phases of the test should be considered in estimating stresses and in passing opinion on the safety of the structure.

H. F. MOORE,
Assistant Professor of Theoretic and Applied Mechanics, University of Illinois,
Urbana, Ill.

Topographic Survey of Rough Wooded Area

SIR: Having read with much interest the article in the Engineering Record of March 4, page 316, entitled "Unusual Methods Simplify Topographic Survey of Rough Wooded Area," and the "challenge" of the same appearing in the issue of April 1, page 459, I wish to enter my dissent from certain statements in the "challenge." The writer thereof states that the location of contours directly with a wye level and recording with a plane table, is a *most unusual* method. To this I can only say that my limited experience tells me the contrary. As to his assertion that work done in that way can only be done "at unusually high unit costs," I would offer the following:

Within the past few years I have completed two topographic surveys, each of which was done by plane table, using the wye level to locate contours. The first job was in a wild section of New England, a precipitous, winding river forming the nucleus of the map, and the banks now rising abruptly from the water's edge, and then following tributary valleys back sometimes for two miles. Most of the country was wooded, not with heavy trees, but with New England "second-growth" mixed with underbrush. The scale of the maps was 200 ft. to 1 in., and the contour interval 5 ft. The second was a similar river survey, but this time the river fell more gradually and the banks were not so high. Also, there was a slightly larger proportion of cleared fields and meadows, although the added thickness of the underbrush in the wooded areas largely offset that advantage. The scale and contour interval were the same as in the first case.

In each survey a meandering base line was run by azimuths on each bank of the river and bench marks frequently established. These lines were checked with each other frequently. From each of these lines meandering lines, wtih levels, were run back from the river, following the tops of the banks, extending up the ravines and valleys, and generally establishing all points needed for plane-table occupancy, returning to and closing on the main line on the river bank. In this way an absolute check on the accuracy was maintained at all times. The party for such work consisted of an engineer in charge, transitman, leveler, two tapemen, rodman and one extra efficient axeman. The points thus established were later occupied by one or the other of two plane-table parties, each consisting of a plane-table operator, leveler and two rodmen. One base line and two plane-table parties were used continuously.

The cost of the field work on the first survey cited was 37.7 cents per acre for base line and 46.2 cents per acre for plane tabling; on the second job, 25.8 cents per acre for base line and 20.9 cents for plane tabling. Office work added 7.5 cents per acre to the cost of the first work and 5.6 cents for the second, making totals respectively of 91.4 and 52.3 cents. Rainy days cost 5.7 cents on the first and 5.8 cents on the second, which the reader may add if he desires.

In order to give full meaning to the above figures I should emphasize that they are *costs of work* and not the total cost of the surveys. In each case the work was in a remote region, several miles from a railroad or source of supplies. The men were brought to the scene from a distance and a camp was maintained for their accommodation, board and lodging being furnished in addition to their wages. Supplies were bought at distant wholesale houses, shipped by rail and teamed to the camp. The total costs per acre for railroad fares, camp maintenance, cost and depreciation of camp equipment and surveying instruments, in fact for everything charged to the job at the main office, was $2368 on the first job and $1769 on the second.

FRED J. WOOD.

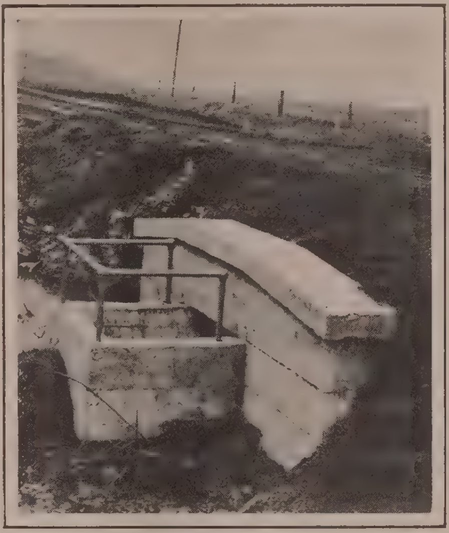
Brookline, Mass.

Wing-Wall Weirs to Prevent Soil Erosion

SIR: In the Feb. 26 issue of the Engineering Record, page 289, I note an article pertaining to the construction of a wing-wall weir in California, which was used to prevent soil erosion.

Construction producing similar results has been used for some time in this state in the design of small highway culverts, as illustrated by the accompanying photograph. The culvert in this instance is a small box culvert provided with a rectangular box at the upper end, which allows the water to run off and the sediment to deposit at the upper end of the culvert.

A great many culverts constructed in this manner have been built in the state in the past few years. This particular one is in Cedar County, and was built in 1914.



RECTANGULAR BOX STOPS SEDIMENT

IOWA HIGHWAY COMMISSION,
By J. H. Ames, Bridge Engineer.
Ames, Iowa.

What Is an Engineer?

SIR: The recent canvass among practising engineers to determine the consensus of opinion as to the relative value of certain characteristics leading to success in the engineering profession has brought to light some interesting facts. These findings, though preliminary to some extent, have been criticised by a few. This is to be expected, especially from those directly interested in teaching technical students, for the factors given most prominence in schools of engineering show a small percentage in the tabulated report based on the data secured in the canvass. However, as the data secured in this manner represent a general opinion, there must be considerable truth in the points made and it is to be expected that some of the schools will modify their curriculum to approach more nearly the desired conditions.

It appears to the writer that there are three causes operating to the detriment of engineering schools in general and also to that of the young graduate engineer.

First—Too many teachers of the branches of engineering have been advanced to their positions with no opportunity to engage sufficiently in practical every-day work. An educator in engineering should by all means have had many years of successful practical work and thus have developed many of those attributes which mean so much toward success.

Second—The student is, in many cases, led to believe that when he graduates he will become at once a full-fledged engineer and so naturally expects many things which do not materialize. He thinks that he can at once take his place in the engineering world and acquit himself with credit to himself and his alma mater. This view is sometimes a serious handicap to a promising young man and not infrequently lowers the estimation his employer places upon him.

Third—The engineering student is hampered by the same lockstep system which is so detrimental to the efficiency of our common graded-school system. By this statement I mean that a certain definite time is taken for each study or branch of learning, and this time is much too long for the more brilliant students in that line and too short for those who have no aptitude for that particular study. Thus the best students are held back and the slower ones rushed forward. Practically every student is brilliant in some branches and slow in others, and should be allowed to progress just as rapidly as he is individually able. Surely some method can be evolved which is at least a compromise between class instruction and purely individual teaching.

If these three troubles could be obviated engineering education would be placed at once on a much more satisfactory plane, and students could be graduated with a much better chance of rapid success in their chosen profession.

Boone, N. C. D. R. SHEARER.

Who Must Pay for the Transit?

SIR: I had a transit knocked over and damaged by a man driving against it. It was in use running the center line of a street for the city. There was plenty of roadway and several teams had passed. Can I compel the party to pay damages for knocking over the instrument?

SURVEYOR.

Pennsylvania.

Meters Read by Mail

HOW the Kansas City (Mo.) water department secures meter readings by mail when its representatives find nobody at home during their round of calls at consumers' houses is told in last year's annual report by D. L. Wheelock, superintendent of the meter division. When the meter reader cannot enter the building he leaves a postal card, marking the license number, premises and date he called. On this card is a fac-simile of a regular meter dial, with the hands blank. The consumer is instructed to take the card and mark the location of the hands. The card is then mailed to the office, where the reading is compared and put in the route book. The department receives on an average of 600 cards each month and finds only about 5 per cent in error.

The results from this system are said to be very beneficial. It gives the consumer the idea that the department needs his cooperation. The consumer learns to read his meter and, most important of all, the system saves making up an estimated bill, which, no matter how estimated, causes a great deal of trouble and complaint from the consumer. It thus saves the men in the collection division much time.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

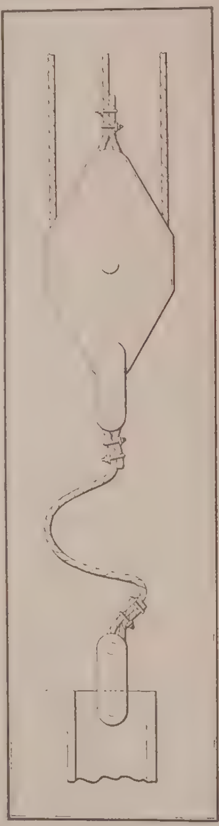
Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Jerking with Weighted Block Pulls Sheet Piles Easily

By H. S. CARPENTER
Cobleskill, N. Y.

BADLY-BENT steel sheet piles have been pulled by the writer with the rigging shown in the accompanying drawing. A weight block, or an ordinary block with some heavy weight tied closely to it, is shackled to a piece of cable about 10 ft. long, the lower end of which is secured to the pile. The fall line is slacked off and taken up with a run by the hoisting engineer, the momentum of the heavy block, in addition to the strain on the hoisting line, producing something like a sharp upward blow when the lower cable comes taut. The writer has never come across a sheet pile stuck so tightly that it could not be pulled in this way by a skillful hoisting engineer. A derrick or any other hoisting rig handy, of a few tons capacity, can be used. It is not desirable to reave up a heavy set of falls, as it is the jerk of the weighted block that does most of the actual work.



Ends of Paper Casing Pull Out After Form Rods Are Removed

By D. P. LANE
Assistant Chief Engineer, Unit Construction Company, St. Louis, Mo.

SECTIONAL paper tubes, similar to mailing tubes but dipped in paraffine, were used recently to permit the removal of long tie rods in taking down the forms for a heavy concrete wall. By catching a sharp hook in the end of the tube, it was easy to unwind and pull out a few inches of the paper at each end when the tie-rod holes were plugged.

The work involved a concrete wall 385 ft. long, 34 ft. high and tapering from 25 ft. wide at the base to 3 ft. at the top. The writer suggested for the ¾-in., ⅝-in. and ¼-in. rods used to tie the wall forms the use of these paraffined paper tube casings, which were ordered from the St. Louis Paper Can & Tube Company. They were the ordinary spiral-wound mailing tube dipped in a bath of hot paraffine. They were furnished in 3 and 4-ft. lengths, and each length was provided with a 3-in. sleeve at one end for covering the joints between sections. The inside diameter of the tubes was ⅛ in. larger than that of the rods.

After the concrete had set the rods were removed without the least difficulty, and the ends of the paper tubes were unwound as described with a hook and removed to a depth of 4 in. before plugging the holes. These tubes were the first order for this purpose that the manufacturer had ever filled. The cost, delivered on the job, was about 1¼ cents per lin. ft. of tube.

Cofferdam Bracing Removed Economically at Baltimore Bridge

PRACTICALLY all of the cofferdam bracing in the piers for the Hanover Street bridge at Baltimore, the construction of which is described on page 632 of this issue, was removed without being cut. Roughly outlined, the method was as follows:

As the concrete of the pier shaft reached a layer of bracing the ranger course below that layer was blocked to the pier shaft and the layer itself removed. This left the cofferdam temporarily unsupported for two vertical spans. So far the usual method was followed. Instead, however, of sawing the bracing out inside the form, it was taken out in whole sticks. The longitudinal braces, which were in short lengths, spanning between the cross braces, were at once removed from the cofferdam. The cross braces, being single sticks reaching clear across the coffer, were too long to be tilted enough to take them out through the pockets. Rather than cut them, they were turned parallel to the long side of the coffer and laid on the blocking from the ranger below to the pier.

As the concrete came up the forms were stripped and the water allowed to rise. It did not have to be pumped down again. A tool shaped like one-half of a pair of timber hooks, but with a horizontal leg long enough to pass clean under a timber, was lowered through the water by one of the derrick boats and used to jerk out the blocking between the rangers and the pier shaft. The pulling was easy, as there was no outside head on the coffer. This procedure at once allowed the long cross braces to float to the top. All that remained to be removed was then the rangers themselves and the posts between them. This was accomplished with comparatively little breakage by swinging the hook against the sheeting and pulling it up.

By this method extra pumping charges were saved, only a small crew was required, no one had to work down below while the bracing was being pulled, and a large salvage, it is said, was realized on the timber. The bridge is being built by H. P. Converse & Company.

Quarantine to Save Timber

The first lumber quarantine on record was put into effect recently. The U. S. Department of Agriculture has asked Eastern nurserymen to aid in fighting white-pine blister rust by shipping west of the Dakotas, Nebraska, Kansas, Oklahoma and Texas no white-pine nursery stock or currant and gooseberry bushes which carry the rust.

LONG CROSS BRACES WERE LAID AT SIDE OF PIER SHAFT AS REMOVED TILL STUB BRACING WAS PULLED WITH HOOK AFTER FLOODING

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Recommend Sedimentation and Disinfection of Detroit's Sewage

The report on the disposal of sewage at Detroit, Mich., on which Clarence W. Hubbell has been working for the past year and a half, recommends that treatment works be located at Fort Wayne and Fairview, on the river front, and a plant be provided on Connors Creek for future use. The recommended treatment is by means of Imhoff tanks combined with disinfection. The first cost of complete installation is estimated at $6,091,000.

The plants, it is estimated, will take care of the sewage from a population of 950,000. Each plant is to have its own system of collecting sewers. Sludge is to be disposed of by filling low lands, incineration or sold as fertilizer. The total annual charge, including interest at 4½ per cent, amortization, operating cost and maintenance, is given as $517,430.

U. S. Senate Passes $85,000,000 Good Roads Bill

The Senate, on May 8, passed the Bankhead good roads bill. $85,000,000 will be spent by 1921 for road construction, contingent on an equal expediture by the states. For roads in national forests $10,000,000 is provided. For the year ending June 30, 1917, $5,000,000 is appropriated with increasing expenditures until 1921. The money is to be apportioned by the secretary of agriculture, on a basis of one-third in the ratio of the area to which the states bear to the total area of the country, one-third in the ratio of population, and one-third in the ratio which the mileage of rural delivery routes bears to the total mileage in the country.

The measure is a substitute for the Shackleford bill, which passed the House, and provided that not more than $25,000,000 should be appropriated annually by the government.

Candidates Nominated for American Waterworks Election

The nominating committee of the American Waterworks Association has selected the following candidates for office to be balloted on prior to the association's thirty-sixth annual convention in New York City, June 5 to 9:

For president, Leonard Metcalf, consulting engineer, Boston, Mass.; for vice-president, Theodore A. Leisen, general superintendent, Board of Water Commissioners, Detroit, Mich.; for treasurer, James M. Caird, consulting engineer, Troy, New York; for trustees, F. W. Capplen, city engineer, Minneapolis and M. L. Worrell, general manager of waterworks Meridian, Miss.

Vessel Smashes Two Head Gates on Welland Canal

Two headgates at lock No. 8, at St. Catherines on the Welland Canal, were smashed April 30, by the steamer W. J. Averell. The accident was attributed to the steel hawser getting caught in the vessel's compressor and not being placed on the post on the lock wall to check the vessel's speed. The damage is estimated at approximately $3,000.

The rush of water from lock 8 carried the vessel and towpath gate out into the lower reach. The ship was not damaged and there was no overflow, due to the fact that the lock below No. 8 is about 1¼ miles long, while the one above is short. Traffic was resumed with a short delay for replacing the gates.

For a Summary of the Labor Situation As It Affects Construction Work See Contracting News Section

"Paper Mobilization" Proposed by Captain Park

An essential feature of plans for preparing the engineers of the country for military duty, as discussed at a recent joint meeting of engineers, in San Francisco, should be the compilation and maintenance of a record of the names and addresses of technical men. "A paper mobilization" is the scheme proposed by Capt. Richard Park. One salaried secretary could be established in the engineering center of each state, to compile and maintain a card index showing names, addresses and experience of engineers, skilled laborers and mechanics. The cost would be small and the information almost invaluable in event of war.

Portland Engineers Make Investigation of Trunk Sewer

Owing to charges that the Montavilla trunk sewer in Portland, Ore., was unsatisfactory, the Portland association of members of the American Society of Civil Engineers appointed a committee to investigate the matter. The committee was composed of George C. Mason, J. P. Newell and J. L. Stannard.

The committee after a careful examination of the structure reports that it is entirely satisfactory, thus vindicating the city engineer and others against whom the charges were made. For the good of the service and of the engineering profession the committee rcommends the discharge of those employees of the city who aided in spreading false and malicious reports regarding the condition of the sewer.

G. A. Kyle, who reported independently on behalf of the residents of Montavilla, reached the same conclusion as the committee.

Engineering Society Comes to Aid of Canadian City Engineer

G. W. Craig, city engineer of Calgary, Alberta, Canada, who was recently criticized for the failure of a reinforced-concrete arch bridge over the Bow River, has been absolved from all blame.

The city council of Calgary ordered an investigation to ascertain whether Mr. Craig was guilty of adopting an unsafe design and using unsuitable material. The Calgary branch of the Canadian Society of Engineers immediately offered the services of its members in settling the technical questions involved. Investigation by the engineers showed that Mr. Craig had used every precaution in the design and erection of the structure. The city council has adopted a motion to that effect.

Break Ground on $3,000,000 Nave

Work was started May 8 on the $3,000,000 nave of the new Protestant Episcopal Cathedral of St. John the Divine, in New York City. As noted in previous issues, this will be the largest church in the western hemisphere.

Will Construct $6,000,000 Reservoir Near Wanaque, N. J.

Governor Fielder, of New Jersey, appointed George G. Wright, of Paterson; E. E. Hincke, of Montclair; Mr. Ramsey, of Perth Amboy, and Laurent Tonnelle, of Bayonne, members of the New Jersey Water Commission, May 5. This commission will construct a reservoir in the vicinity of Wanaque, N. J., to supply the cities and towns of northern New Jersey with drinking water. The commission will organize soon and it is rumored that Morris R. Sherrerd, chief engineer of the board of street and water commission, of Newark, will be appointed chief engineer for the commission. The cost of the reservoir, dam and pipe lines is estimated at $6,000,000.

Rebuild Tracks of First Western Railway for Monument

A monument to early American railroading will be dedicated by the College of Mechanical and Electrical Engineering of the State University of Kentucky, at Lexington, in connection with the celebration of the university's silver jubilee. The monument will consist of the restoration of a portion of the original track of the Lexington & Ohio Railroad (now the Louisville & Nashville), the first railway west of the Allegheny Mountains.

The original track consisted of stone "sills" upon which were placed ½ x 3-in. wrought-iron rails 14 ft. long. The ends of the rails were miter-jointed and fastened by spikes driven into lead-filled holes in the stone. About 25 ft. of this original track will be set in a concrete base on the university campus in front of Mechanical Hall. Efforts are being made to secure a locomotive of the 1835 period to place on the track.

New Filtration Plant May Be Built at East Chicago

The public service commission of Indiana has announced that it will immediately order the East Chicago and Indiana Harbor Water Company, of East Chicago, to file plans and specifications for a filtration plant within sixty days. The cost of the complete new filtration system is estimated to be $150,000. John C. Diggs, water chemist of the State board of health, said the water now obtained from Lake Michigan was polluted by sewage from the East Chicago ship canal and from other sources. The state board of health of Indiana condemned the supply.

Electrical Engineers Hold Annual Meeting by Telephone

The national meeting of the American Institute of Electrical Engineers will be held May 16 in San Francisco, Chicago, Atlanta, Philadelphia, New York and Boston. The various meeting halls will be connected by long-distance telephone. Every seat will be equipped with a receiver so that each member will hear the proceedings at the gatherings in the other cities.

Error Action by Anti-Conservancy Counties Overruled

Every ground on which the anti-conservancy counties of Ohio endeavored to have the organization of the conservancy court declared illegal was completely overruled May 6, by the court of appeals of the fifth district. This is another victory added to the successes which the conservancy law has met in the courts.

Bridge Erected by Chinese Contractor

THE PICTURE SHOWS A NEARLY COMPLETED BRIDGE ON THE CANTON-HANKOW RAILWAY, IN SHA HU, CHINA. THE DECK SPANS ARE EACH 40-FT. THE ENTIRE WORK WAS DONE BY CHINESE CONTRACTORS UNDER THE DIRECTION OF R. A. WHITE, FROM WHOM THE INFORMATION AND PHOTOGRAPH WERE SECURED.

Offer Business Men's Course of Training in Export Business

A course of training for business men for work in the export business has been prepared by Dr. Edward E. Pratt, chief of the bureau of foreign and domestic commerce, in co-operation with other prominent men, including O. P. Austin, of the National City Bank of New York; E. N. Vose, editor of Dun's International Review; E. A. De Lima, president of the Battery Park National Bank of New York; Prof. Emory R. Johnson and Dr. G. G. Huebner, of the University of Pennsylvania.

The course is designed to aid manufacturers, bankers and commercial houses in developing men to handle foreign business. The course is under the management of the Business Training Corporation, 185 Madison Avenue, New York City, of which W. H. Lough is president.

Illinois Architects Want Branded Structural Timbers

Standard specifications for southern yellow pine structural timbers were adopted by the Illinois Society of Architects, April 25. When maximum durability and strength are required, the specifications call for longleaf southern yellow pine "of select structural material," in accordance with the definition of "dense southern yellow pine" as adopted by the American Society for Testing Materials (August, 1915), and the Southern Pine Association (Density Rule Book, March 15, 1916). The brand shall be in accordance with the official requirements of the association.

When strength is required without special reference to durability, the specification calls for southern yellow pine of "structural material" as defined above. The word "longleaf" is omitted.

No. 1 common southern yellow pine timbers of "dense" grade, as defined in the density rule book of the association, are to be called for when the lumber is to be used without reference to durability or maximum strength.

No. 1 common southern yellow pine as defined in the density rule book, is to be used for joists, studs, etc., in ordinary or minor structures without reference to durability or maximum strength. (Note the word "dense" is omitted.)

For heavy factory and laminated flooring, when durability and strength are required, "dense" southern yellow pine of "merchantable grade" is to be used. When strength only is wanted, southern yellow pine of "No. 1 common timbers" will answer.

In lieu of branding, the contractor may have the material inspected by the inspection department of the Southern Pine Association, but he must then furnish, to the architect, a certificate showing that all material complies with the architect's specifications.

An Argument Against Hard Roads

Many have been the stories embodying fanciful objections to hard roads. The following incident, vouched for by the engineers of the Du Pont road, is worth adding to the list:

Shortly after the construction of one of the sections of concrete road there was an "experience meeting" in the nearest country store. Judging by the encomiums, opponents of concrete were few in that neighborhood. Finally a new customer overhearing the conversation broke up the harmony by declaring that he would never use the road again, nor would any of his family. Pressed for his reason, he replied:

Well, I was driving to town with eggs, and as soon as I hit that concrete road the wagon ran up on the horse and frightened him. He started to kick and broke every last egg in the rig. I ain't going to try no such road again."

Blame Faulty Construction for Fires in Wooden Buildings

The lumbermen of the United States will ask the government to make a comprehensive census of the nation's fires. From the data they hope to show that the susceptibility of wooden structures to fire has been over-estimated and that the real cause of fires is improper construction. Local investigations, according to reports from the National Lumber Manufacturers' Association, have shown that fires in several cities were caused by faulty placing of joists in chimneys and improper flue linings, the fires starting through careless exposure and violation of building regulations.

Will Do Small Part of Aurora Track Elevation This Year

Authority has been granted by Board of Directors of the Chicago, Burlington & Quincy Railroad to proceed with the track-elevation work at Aurora, Ill. The total estimated cost of the improvement is $4,000,000. The work to be done this year is confined to bridge work on the new alignment, where there will be no interference with present tracks and operation.

The project as a whole involves track elevation of the main line from east of Farnsworth Street to a point a mile west of Rathbone Avenue. Some sixteen grade crossings will be eliminated and a sag in the present profile will be materially lessened. The main tracks will be swung to the south to a new location a maximum of 250 ft. from the present tracks from Wood Street to the Aurora station, thereby reducing the main-line curvature and providing ground for the expansion of the yard at this point.

Beginning at South Broadway, there will be a cut-off a mile long to a point near the Elgin, Joliet & Eastern Railway crossing. This cut-off will eliminate considerable curvature. It will cross the Fox River on an island, involving two short arch bridges instead of the single bridge now in use. It will also involve a relocation of the junction with the Savanna Branch to a point just west of the westerly river crossings. The old line will be retained for industrial purposes.

The work to be done this year will be confined to this cut-off. The details of the bridges are not yet fully worked out. It is settled, however, that all bridges on the improvement, including those over the two arms of the Fox River, will be of reinforced-concrete; with steel fascia girders at one or two of the most complex skew crossings.

The work is being carried out under the direction of the engineering department of the Chicago, Burlington & Quincy Railroad, of which T. E. Calvert is chief engineer, and C. H. Cartlidge, bridge engineer.

Attorney Explains Pennsylvania Highway Laws

According to a recent interpretation of the state laws by William H. Keller, first deputy attorney general, the state highway department is not permitted to construct or improve, as a state-aid highway, any section of a state highway route within the limits of a borough. This opinion upsets the plan under which the state highway department has been acting in the past, whereby state-aid money has been used for construction work on state highways. As a result, many of the boroughs wherein the state highway department had planned to do work during the coming season, on a state-aid basis, will be deprived of this improvement.

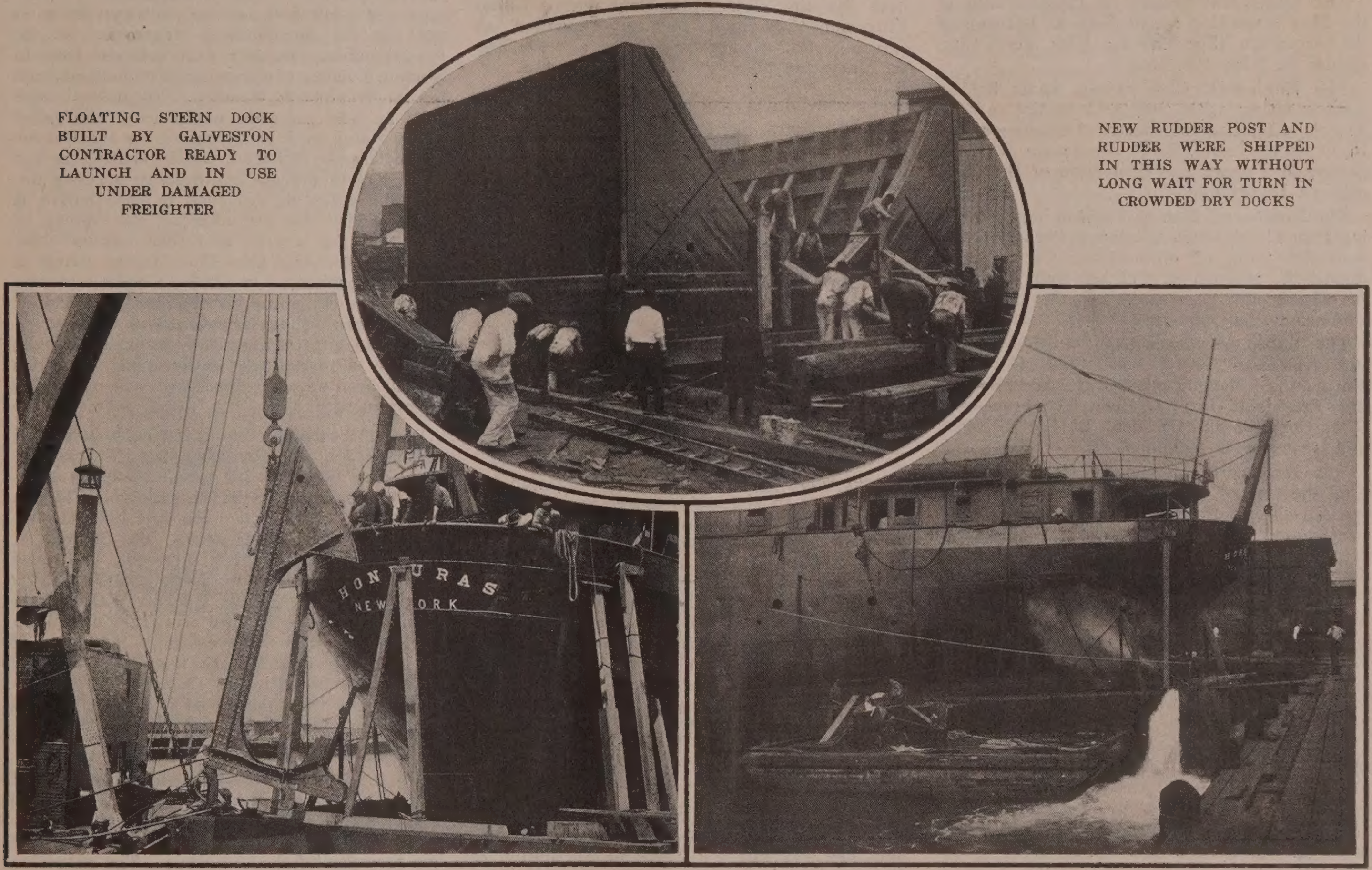
The deputy attorney general also stated that if a street has been reconstructed with permanent pavement material, the maintenance cost thenceforth is at the expense of the borough, but if it has been constructed or improved with any type of construction not coming within the term "permanent paving" material, the state highway department must pay 50 per cent of the cost of maintenance, this money to come out of the state highway funds.

An opinion was also given to the state highway department to the effect that existing legislation does not authorize the highway commissioner to build state-aid highways in townships on state highway routes; that townships and counties may, under the Act of 1913, contribute to the cost of reconstruction and improvement of state highways in townships in the same manner as provided for state-aid highways; that the entire cost of maintenance and repair of such state highways reconstructed by the aid of townships and counties must be paid by the state and that the state's share of such reconstruction and maintenance must be paid out of state highway as distinguished from state-aid highway funds.

Contractor Builds Stern Dock to Put Rudder Post on Steamer

By unwatering the stern of the large ocean freighter Honduras in a floating timber stern dock, which a Galveston contractor built in five days, a new rudder post and rudder were set on the steamer without the long delay of waiting for one of the Gulf Coast drydocks to be vacant. As shipping is at a premium and all the yards within reach were busy, this novel method of making repairs was resorted to.

The vessel was towed into Galveston harbor with her stern frame completely broken off, and steamed out 24 days later, in perfect condition, to load sulphur at Freeport, Tex. Within that time the stern dock was built and placed, measurements taken and a new stern frame and rudder designed, fabricated and permanently erected. The dock was built by R. F. Koeppe, a general contractor of Galveston. The repairs were carried out by the McDonough Iron Works of the same city, while the Texas Carnegie Steel Company fabricated the repair parts.



FLOATING STERN DOCK BUILT BY GALVESTON CONTRACTOR READY TO LAUNCH AND IN USE UNDER DAMAGED FREIGHTER

NEW RUDDER POST AND RUDDER WERE SHIPPED IN THIS WAY WITHOUT LONG WAIT FOR TURN IN CROWDED DRY DOCKS

Offer Two Weeks' Business Course

A short course in factory organization, cost accounting and scientific management is offered by Pennsylvania State College. Registration day is Aug. 7 ,and the course ends Aug. 19. The course is under the direction of Prof. Hugo Diemer.

Augusta Adopts Rigid Building Code After Big Fire

At a recent meeting of the city council of Augusta, Ga., the official code of the National Board of Fire Underwriters was adopted.

Ask Engineers' Support for du Pont's Presidential Nomination

Coleman du Pont, until recently president of the E. I. du Pont de Nemours Powder Company and at present in control of the Equitable Life Assurance Society, is a candidate for the Republican nomination for President of the United States. He is a graduate of Massachusetts Institute of Technology, and appeals to the engineers of the country for their support.

While Mr. du Pont is primarily a business man, his engineering education at Massachusetts Institute of Technology led to a position as engineer for the Central Coal & Iron Company, of Central City, Ky., from which he rose to become managing head of the company. He left Central City in 1893 to become general manager of the Johnson Company, of Johnstown, Pa., only to return three years later to engage in business for himself. He was soon made president of several Kentucky coal and iron companies, and was also interested in railway and street car systems. In 1900 he was made president of the E. I. du Pont de Nemours Powder Company and in fifteen years of service increased the company's assets from $15,000,000 to $80,000,000. He resigned from that position in 1915, and since then he has devoted his time to the Equitable Life Assurance Society, in which he holds the controlling interest.

New York City Needs Press Agent

That many important measures affecting the city are threatened and killed because the public does not understand or take interest in them is the belief of Mayor Mitchel, of New York City, as expressed by him in a recent address to the members of the Advertising Club, of New York City. According to the mayor, the power of the Senate or Assembly is almost worthless if the interest of the general public is not aroused to a point of enthusiastic support or emphatic opposition.

The present methods of giving publicity to public affairs by means of interviews with and statements by officials, are, according to Mayor Mitchel, far from satisfactory. He solicited, and was promised, the help of the advertising men present in solving the problem of how best to arouse public interest.

Engineering Societies Are Doing Good Work, Says C. E. Drayer

At a meeting of the Nashville section of the Engineering Association of the South, C. E. Drayer, secretary of the Cleveland (Ohio) Engineering Society, pointed out how engineering associations throughout the country are bringing citizens and government officials to a better appreciation of the importance of the engineer.

The engineers of Nashville became so enthused by Mr. Drayer's words that a committee was appointed to co-operate with the central health committee in a campaign for sewer extension and sanitary improvement. The committee consists of C. P. Connell, assistant city engineer; Prof. W. H. Schuerman, of Vanderbilt University; F. E. Freeland, county bridge engineer; J. H. Allen, secretary engineer, and Wilbut Nelson, geologist.

Engineering Corporation Opens Sugar-Engineering Department

After several years of investigation of problems to be met in sugar manufacture, the J. G. White Engineering Corporation of New York City has organized a sugar-engineering department. The new division offers advice in the efficient production of cane and in the design, construction and operation of sugar-manufacturing plants. The J. G. White corporation is not affiliated with any company engaged in the manufacture of machinery or supplies used in the production of sugar.

Build 1000 Farms for Soldiers

One thousand completely equipped farms entailing an expenditure of about $3,500,000 are being rushed to completion by the Canadian Pacific Railway for the use of soldiers who have served in the European war. The funds for this patriotic memorial came through the department of natural resources of the Canadian Pacific and the plans involve the construction of 1000 houses and barns, 1200 miles of fence, and digging of 1000 wells.

Want 3000 Recruits by June 1

A campaign is being conducted by the National Guard of New York to secure 3000 recruits during May. Lieut.-Col. E. W. Van C. Lucas, Corps of Engineers, N. G., N. Y., at 216 Fort Washington Avenue, New York City, urges the engineers of New York state to enlist.

Engineering Society Activities

The Engineers' Club of Philadelphia will hold its annual meeting May 16, at which officers will be elected.

The Engineers' Society of Pennsylvania at the May 5 meeting heard John E. Lathrop of the American City Bureau, New York City, lecture on "City Planning."

The Engineers' Club of St. Louis held a joint meeting with the local section of the American Institute of Electrical Engineers May 10, at which Terrell Croft, consulting engineer, presented a paper on "Protection of Buildings Against Lightning."

The Engineers' Club of Trenton held a meeting May 11, at which "National Preparedness" was the topic of discussion. Congressman Martin B. Madden of Chicago and Frederick B. Chase, field secretary of the American Defense Society, spoke.

The Baltimore Association of Members of the American Society of Civil Engineers elected the following officers at a recent meeting: President, Harry D. Bush; vice-presidents, R. K. Compton and Col. John Biddle; secretary and treasurer, C. J. Tilden.

The Engineering Society of Buffalo at the final meeting of the season re-elected the following officers: President, John Younger; vice-presidents, W. A. James and J. G. Melendy; treasurer, William Dollar; secretary, W. J. Gamble. Over 200 members attended.

The Engineers' Society of Western Pennsylvania will hold the third of a series of military preparedness lectures May 17. Capt. C. L. Sturdevant, Corps of Engineers, U. S. A., will outline the subject of field fortifications, methods of trench warfare and siege operations.

The Colorado Association of Members of the American Society of Civil Engineers will meet this evening to hear Andrew Weiss, project manager of the U. S. Reclamation Service, discuss the drainage of irrigation projects, with special reference to the North Platte project.

The Brooklyn Engineers' Club met May 11 to witness the presentation of a paper by A. H. Rhett, formerly engineer of structures for the New York, Westchester & Boston Railway, on the waterproofing of structures subject to stress from moving loads and temperature variations.

The Georgia Drainage Association met May 4 and 5 at Monroe, Ga. Officers were elected as follows: President, A. R. Lawton, Savannah; vice-presidents, T. A. Pate, Grayson; Dr. J. A. Pirkle, Monroe; E. A. Copelan, Greensboro, and L. R. Akin, Brunswick; secretary and treasurer, S. W. McCallie, Atlanta.

A joint meeting on Military Preparedness, invitations to which were sent to all San Francisco members of the American institutes of electrical and mining engineers and the American societies of civil, mechanical and chemical engineers, was held in San Francisco May 2. The speakers were: Capt. Richard Park, Corps of Engineers, U. S. A.; Capt. John Murphy, Coast Artillery, U. S. A., and A. H. Babcock, member of the Naval Consulting Board. A resolution was adopted requesting the local officers of each of the five societies to appoint a committee to facilitate co-operation among engineers in military preparedness matters, and to represent the engineering profession in military matters in the state of California.

What Engineers and Contractors Are Doing

C. CHAUNCEY SMITH, architectural engineer, formerly with Aaron H. Gould, architect, of Portland, will assume charge of a new office opened by the Gould Engineering & Contracting Company in the Fulton-Dement Building, Astoria, Ore.

VIRGIL G. BOGUE, consulting engineer, of New York City, has removed his office to 26 Cortlandt Street.

CHARLES HARDING, erecting engineer for the New York Continental Jewell Filtration Company, formerly engaged at Reading, Pa., is now installing a 4,000,000-gal. filtration plant at New Albany, Ind.

HENRY JENSEN, general contractor, of Glasgow, Mont., has opened a permanent office in the Patterson Building. In connection with his general contracting business, Mr. Jensen will handle a line of cement.

J. D. MCLEOD was recently appointed city engineer of Helena, Mont.

JOHN R. SEXTON has been appointed division engineer of the Meadville division of the Erie Railroad, succeeding C. Bucholtz, promoted.

M. F. RATHER, who recently resigned from his position with the engineering staff of the Wisconsin Railroad Commission, has accepted an appointment with the Johnson Service Company, of Milwaukee, Wis. Mr. Rather was connected with the commission for three years in the water-power and the land and building departments. His work for the Johnson Service Company will be in the sales division, with headquarters at Dallas, Tex.

CALVIN W. HENDRICK, chief engineer of Baltimore, Md., has been appointed chairman of a committee to standardize all materials and supplies purchased by the municipal government.

WALTER LEE, water engineer for Baltimore, Md., is a member of the committee to standardize all materials purchased by that city.

J. H. MERRIAM has been transferred from Kansas City, Mo., where he was resident engineer for the Chicago, Burlington & Quincy Railroad's bridge over the Missouri River, to Yutan, Neb., where he will have charge of a 75-ft. bridge for that railroad over the Platte River.

WALTER ROWLAND, who has been associated with the Isthmian Canal Commission and the Panama Canal since 1907, has terminated his services with the government. He has under advisement an offer from the Chile Exploration Company, in connection with its intended developments in Chuquicamata. Mr. Rowland was in charge of design of the docks and piers of the new Pacific terminals of the canal, amounting in value to $3,400,000 and comprising over 7600 lineal feet of steel and reinforced-concrete dock construction. Mr. Rowland was graduated from the civil engineering department of the University of Vienna in 1896, where he remained as an assistant until 1898. From the latter date until 1905 he was actively engaged in engineering work in Europe. He was engaged by the Twin City Rapid Transit Company, of Minneapolis, for a short time and was later associated with A. W. Hunking, consulting engineer, of St. Croix, Wis. He became connected with the Isthmian Canal Commission in 1907.

EDWIN CORR, lawyer, of Bloomington, was recently appointed a member of the public service commission of Indiana. He has been a member of the legislature and deputy attorney general of that state.

R. K. BROWN was promoted from the position of division engineer to that of engineer, maintenance-of-way, for the San Pedro, Los Angeles & Salt Lake Railroad, May 1, with headquarters at Los Angeles. Mr. Brown obtained his first railroad experience with the Pennsylvania at the age of 16. He later attended Rensselaer Polytechnic Institute, returning to the Pennsylvania after graduation. After ten years with that road, he went to the San Pedro, Los Angeles & Salt Lake Railroad in 1902 as division engineer.

E. F. MITCHELL was appointed engineer of the western group of the presidents' conference committee on federal valuation of railroads, May 1, with headquarters at Chicago. Mr. Mitchell entered railway service in 1864 in the construction department of the Pennsylvania. He left that road in 1887 to become division engineer, maintenance-of-way, for the Norfolk & Western. From 1890 until 1892 he was assistant engineer in charge of surveys and track construction for the Denver & Rio Grande Railroad, which position he left to engage in private engineering practice until 1900, when he returned to the Denver & Rio Grande. He remained in the employ of that road for a year and then became chief engineer for the San Luis Valley Land & Mining Company. In 1905 he again took up railway work, going to the Missouri Pacific as engineer of construction and chief engineer. He left that position to engage in the practice of consulting engineering, to which he had been devoting his time until his recent appointment.

W. G. STROMQUIST, formerly assistant engineer for the Sanitary District of Chicago, has received an appointment as sanitary engineer with the U. S. Public Health Service, at Cincinnati. He will be active in the Ohio River investigation. Mr. Stromquist was graduated from the University of Illinois in 1910, after which he spent several months with the Champaign & Urbana Water Company at an experimental iron removal plant. For one year he was assistant engineer of Excelsior Springs, Mo. He then spent one and one-half years with the Illinois State Water Survey. In the position he is leaving he had immediate charge of the sewage-testing stations under Langdon Pearse.

H. A. STRAUSS, consulting engineer, of Chicago, has been retained by the Salt Lake & Los Angeles Railway to design the electrification and extension of that 15-mile steam line from Salt Lake to Saltair. The extension is to be a 4-mile stretch to Garfield.

WILLIAM F. COCKE, whose appointment to the position of state road commissioner of Florida was announced in last week's issue, was born in Powhatan county, Va., in 1875. He started engineering work as chairman of the Richmond, Fredericksburg & Potomac Railway, between Richmond and Washington, and was engaged in railroad work in Virginia, West Virginia and Georgia until the panic in the fall of 1907. Shortly after returning to Virginia he secured a position as resident engineer with the Virginia highway commission. In the fall of 1910 he was promoted to the position of division engineer, from which he resigned in April, 1911, to accept the position of county engineer of Wise county. Late in 1912 he resumed the work of division engineer with the Virginia highway commission and continued in charge of the Northern division until Jan. 1, 1916, when he was promoted to the position of engineer of maintenance. He recently accepted the newly created position of state road commissioner for the state of Florida.

W. M. STIEVE, formerly junior engineer for the Public Service Commission, first district, has resigned to become connected with the U. S. navy department, at Washington, D. C.

M. F. Comer, contractor, of Toledo, has been awarded the contracts for two reinforced-concrete bridges with bascule spans across the Miami River, at Miami, Fla.

John V. Stark has left the employ of the engineering department of the New York Central Railroad to engage in private business.

Frank Strong has been promoted to the position of assistant engineer of the Salt Lake division of the San Pedro, Los Angeles and Salt Lake Railroad, succeeding R. K. Brown. Mr. Strong was connected with the engineering department of the Pennsylvania Railroad from 1904 until 1912. He went to the Salt Lake route in the latter year.

D. P. Dale has resigned from his position as assistant county engineer for Sac county, Iowa, to become associated with A. H. Cunningham, engineer, in charge of about thirty drainage districts in Buena Vista and adjacent Iowa counties.

Yates & Yates, consulting engineers, New York City, have been engaged by New London county, Conn., to design and supervise the construction of a 600-ft. highway bridge across the Niantic River.

George B. Walbridge, formerly vice-president of George A. Fuller Company, has formed the Walbridge, Aldinger Company, with offices in the Penobscot Building, Detroit. The new concern will engage in building construction and engineering.

Carl E. Huffstetter, who has been connected with the U. S. engineer's office at Memphis, Tenn., for the past 3½ years, has accepted a position with the Eastville road district, at Eastville, Va. His work will consist of completing the survey of fifty miles of road now being built.

Charles S. Carpenter has resigned from his position as assistant city engineer for Angola, Ind., to become connected with the Des Moines Bridge & Iron Works.

F. Wakeman Sharpe, formerly engineer in charge of construction with the Afton-Windsor Light, Heat & Power Company, is now field engineer with the New York state highway department, at Sanitaria Springs.

Frank A. Ernest has been appointed engineer of construction at the new plant to be erected at Warners, N. J., by the Ammo-Phos Corporation, of 200 Fifth Avenue, New York City.

Albert Freitag, engaged on the head water diversion channel of the Little River drainage district, has been transferred from Whitewater to Advance, Mo.

O. P. M. Goss, consulting engineer for the West Coast Lumbermen's Association and the Association of Creosoting Companies of the Pacific Coast, has been temporarily transferred to Canadian territory to work in conjunction with the forestry department of British Columbia and of the Dominion of Canada. He will acquaint city engineers in Western Canada with the possibilities of creosoted Douglas fir for street paving and other municipal improvement purposes.

C. P. Hill is now employed on the construction of a new reinforced-concrete building at Ocean Park, Cal., as steel foreman.

The Turner Construction Company, of New York City, has been awarded contract for the erection of a seven-story reinforced-concrete factory building for the Pathé Frères Phonograph Company, in Brooklyn.

T. J. Blair, Jr., has accepted a position in the engineering department of the Baltimore & Ohio Railroad. He was formerly resident engineer for Kanawha county, W. Va.

Edgar B. Thomas, who recently resigned from his position in the engineering department of Cleveland, has opened consulting engineering offices in the Leader-News Building, in that city. Mr. Thomas received his education at Franklin College and the Case School of Applied Science. He has been in the employ of the city engineering department of Cleveland for the past fifteen years, nine of which were spent in municipal engineering design and construction and six in charge of river and harbor work.

R. V. Orbison and T. D. Allin, city engineer and engineer of public works respectively, of Pasadena, Cal., have started on a six-weeks' tour of inspection of sewage-disposal plants in numerous cities throughout the United States to secure information that may be useful in the construction of the proposed plant near Ramona Acres, for the joint use of Pasadena, Alhambra and South Pasadena.

John MacMillan, who has been city engineer of South Pasadena for several years, tendered his resignation at a special meeting May 1. Under Mr. MacMillan's supervision the sewer system has been installed and many important street improvements have been made. He has been a member of the tri-city sewer committee, which is considering the purchase of a new sewer farm for the use of the cities of Pasadena, South Pasadena and Alhambra. His resignation has not yet been accepted.

William Mulholland, chief engineer of the bureau of waterworks and supply at Los Angeles, is being urged to go to Dayton, Ohio, to advise with the authorities there in working out plans for flood control. Mr. Mulholland was asked to act as consulting engineer several weeks ago, but felt that his duties in Los Angeles were such that he could not take on any further obligations. However, when a second appeal came from the same source, the Los Angeles Public Service Commission, feeling it was a call for aid from one municipality to another, asked Mr. Mulholland to accept a twenty-day leave of absence for the purpose of complying with the request.

L. C. Scott has recently been appointed to a position on the field party of the bridge department of the Kansas City Terminal Railway, at Kansas City, Mo. Mr. Scott has been county surveyor and highway engineer for Camden county, Mo.; chief engineer for the inter-county seat road commission of that county and was recently engaged in consulting engineering practice, advising on developments involving expenditure of $7,000,000.

Obituary Notes

William F. Heath, a retired contractor, formerly of Minneapolis, died in Tacoma, Wash., May 1, at the age of 83.

Theodore H. McKenzie, consulting engineer, of Hartford, Conn., died May 3, in that city. Mr. McKenzie was born in 1847. His first engineering work was in the employ of the New York, New Haven & Hartford Railroad. After two years with that road, he accepted a position as assistant engineer for the New Haven & Northampton Railroad, which he left two years later to become division engineer for the Connecticut Valley Railroad. He spent several years with various New England railroads and served Meriden, Conn., as city engineer for three years and as street commissioner for one year. He was secretary of the Peck, Stow & Wilcox Company, at Southington, for ten years, after which he resigned to engage in the practice of consulting engineering. Since 1906 he has been engaged on appraisal of water-power, mills and machinery on the new Catskill water supply and was for five years engaged on similar work for the New York State Barge Canal.

Charles Long, who had been in the engineering department of the Grand Trunk Railway for thirty years, died May 1 at Niagara Falls.

John G. McLean, railroad contractor, of Seattle, died recently at Spokane, at the age of 66.

Frederick C. Kunz, consulting engineer, of New York City, died in that city, May 3, at the age of 52. Mr. Kunz was born in Austria and completed his technical studies at the Polytechnical School in Prague, in 1886. He was for several years on the engineering staff of the Austrian Northern (Emperor Ferdinand) Railroad. He came to the United States in the summer of 1891 and found employment with the Pencoyd Bridge Works, in Philadelphia. When this company was absorbed by the American Bridge Company, he became assistant to the vice-president in charge of engineering, with whom he remained until 1903. His most important work while with the Pencoyd Bridge Works was erection of the Niagara and Clifton arch bridges over the Niagara River. Mr. Kunz was at one time consulting engineer of New York City's bridge department, where he was active in preparing specifications and plans for the Manhattan and the Queensborough bridges. Early in 1904 he became chief engineer of the bridge department of the Pennsylvania Steel Company at Steelton, Pa., where he remained for several years. Later he engaged in the practice of consulting engineering, devoting a large part of his time to the writing of his work on "Design of Steel Bridges." Among his last construction work was the steel arch bridge at St. Johns, N. B., over the St. Johns River.

Enos M. Barton, former president of the Western Electric Company, died recently at the age of 74, at Biloxi, Miss.

Joseph J. Duffy, contractor, of Chicago, died May 3 in that city at the age of 56. Twenty-five years ago Mr. Duffy took over the contracting business started by his father. A section of the Northwest Land waterworks tunnel was built by him in 1895. At the time of his death he was engaged in a $12,000,000 lawsuit against the Sanitary District of Chicago, claiming that he was unjustly deprived of a contract for the construction of the canal extension from Lockport to Joliet.

Henry Floy, electrical engineer and valuation expert, died in New York City, May 5. Mr. Floy, who had figured in many important public utility cases during the past twenty years, was graduated from Cornell University in 1891. He was connected with the Westinghouse company for several years and, in 1898, began the practice of consulting engineering in New York City. He installed the 25,000-volt underground transmission line at St. Paul, Minn., in 1900 and had served in many big appraisal cases in various cities in the United States.

Civil Service Examinations

New York.—Examinations for state, county and village service are announced for June 3, applications for which must be received in Albany by May 24. One examination is for assistant electrical engineer, Public Service Commission, First District, salary $1,801 to $2,400. Applicants must have had six years' experience in construction or operation of power stations and heavy traction systems. Applicants for the position of junior assistant engineer, salary $901 to $1,200, must be over 20 years of age. Both examinations are open to non-residents.

Examinations Previously Announced

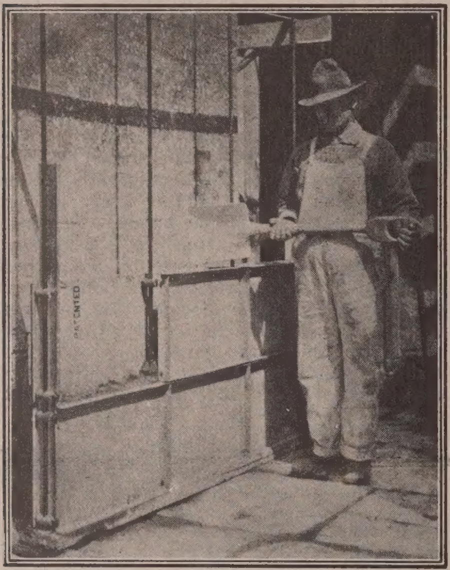
Date	See Eng. Record
Aug. 21-25—Second lieutenant, civilian candidates	April 1

Bridge Company Opens Plant

The new plant of the Anthracite Bridge Company, of Scranton, Pa., was put into operation this week. The concern specializes in structural steel for coal breakers. The officers are: President, Boyd A. Musser; vice-president, N. K. Osborne; secretary-treasurer, Warren Acker. H. E. Detwiller is chief engineer and manager.

Adjustable Metal Forms Simplify Building Problem

The construction of reinforced-concrete walls by the use of metal forms adjustable to the exact thickness of the partition has been introduced by the Pyramid Fireproofing Company, 52 Vanderbilt Avenue, New York City. Vertical steel rods or pipe are placed 2 ft. apart, along the center of the proposed wall. Screws are inserted in steel spacers, previously attached to the rods, and adjusted to the required thickness. The form plates are placed against the hub of the adjusting screws and held in place by a nut threaded on the outer end of the screws. The concrete is then placed.



SHOWING REINFORCING RODS AND METHOD OF ATTACHING FORM PLATES

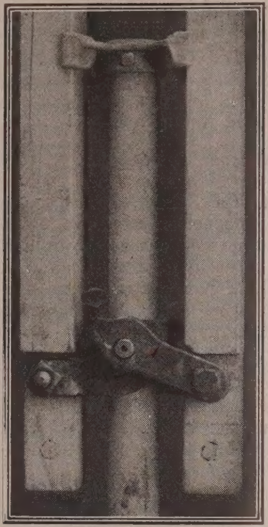
The steel rods, while they hold the plates in position, also serve as reinforcing material. This internal fastening arrangement automatically spaces the forms laterally and prevents any outward collapse. It also permits adjustment of the form plates for thickness and plumb, and makes possible building in successive courses instead of erecting the forms to the full height before placing concrete.

The form plates, being attached by screws, may be removed as soon as the concrete has set. The adjusting screws are said to make possible so nice an adjustment that only a small amount of plaster is required to finish the wall.

Compact Trench Pump Worm Gear Driven by Gasoline Engine

A competent diaphragm trench pump direct-connected by worm gear to a gasoline engine and specially designed to pump muddy and gritty water, is being made by the C. H. & E. Manufacturing Company of Milwaukee, Wis. The pump is mounted either on skids or trucks and the worm gear connects with the engine through a flexible coupling enclosed in a dust-proof housing. Both the 3-in. and 4-in. suction sizes are driven by 2-hp. water-cooled, 4-cycle engines and weigh about 500 lb. each. The 3-in. size has a capacity of 50 gal. per minute, and the 4-in 100 gal. per minute.

Shore Can Be Quickly Adjusted to Fraction of an Inch



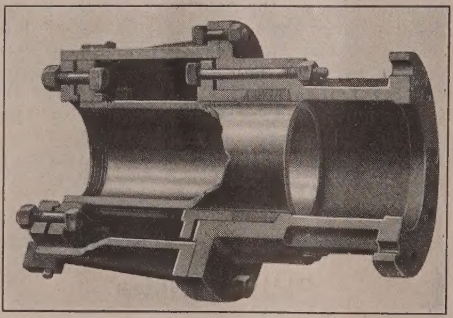
DEVICE IS LIGHT YET STRONG

A self-locking adjustable shore, consisting of a lower member of 1½-in. pipe and an extension member of two legs of two-by-fours, has been perfected by Roos Brothers, engineers and contractors, of Cincinnati, Ohio. The extension member is lifted to the desired height and fine adjustments are made by means of the Roos jacking device (not shown). A thumb screw lock prevents release through jarring and the heavier the load, the tighter the grip. The shore has great strength for its light weight.

Expansion Joint Eliminates Stresses in Pipe

The crosshead-guided expansion joint, shown in the illustration, eliminates all stresses in pipe due to expansion and contraction and is claimed to be adapted to all service for which pipe lines are designed.

These Ross joints are offered with two lengths of sleeves, having a total free travel of 4 and 8 in. respectively. They are said to be sensitive to the slightest variation in length. The larger diameter of the joint is but slightly larger than the ordinary pipe flange; hence the joint takes up but little more space than the straight line itself, and can be covered with the ordinary insulating materials.



EXPANSION JOINT USES STEAM ENGINE PRINCIPLE

This joint is manufactured by the Ross Heater & Manufacturing Company, Inc., Buffalo, N. Y., for all pressures up to 200 lb. per square inch, and for all standard sizes of pipes up to and including 24 in.

Vibrator on Wooden Mats Compacts Concrete in Pavement

In order to imbed the stone, and make a more compact mass, an engine-driven vibrator is used by the Vibrolithic Construction Company of Dallas, Texas, in laying the foundations for "Vibrolithic" pavements. Immediately after the 6-in. concrete slab is raked and smoothed to grade, 1 or 2 in. of trap rock is spread on the surface. Narrow, flexible wooden platforms on mats are then placed on the stone and a vibrator is rolled over the platforms until their bottom edges are brought to grade, resulting in a denser mixture. A coal-tar preparation is later applied to the concrete for a wearing surface.

The accompanying photograph shows the vibrator being used to surface the foundation course on a paving job in Dallas. A Foote boom and bucket mixer is used by the Vibrolithic Company to supply the concrete.

VIBRATORS ARE PLACED ON MATS

Business Notes

Platt Iron Works have removed their Chicago office to the Monadnock Block.

Ford Pulley & Hardware Company of New York City has removed to 432 Fourth Avenue.

J. A. Garber has been transferred to the Chicago office of the Ball Engine Company of Erie, Pa., to handle the sale of Erie steam shovels.

Michigan Scale & Supply Company, 82 Woodbridge Street, Detroit, now represents the Standard Scale & Supply Company of Chicago in Detroit and vicinity.

F. A. Percy has been appointed general sales manager for L. R. Kollock & Company, Railway Exchange Building, Portland. The firm deals in building materials and specialties.

The Southern Clay Manufacturing Company, Chattanooga, Tenn., has purchased the Graves paving brick plant at North Binghamton, Ala., and will begin making wire-cut lug brick at that plant.

Trade Publications

The folowing companies have recently issued trade literature:

Way-Cleanse Company, Sandusky, Ohio. Bulletin 10, 6 x 9 in.; 16 pages. Devoted to Way-Cleanse suction street sweepers.

Edson Manufacturing Company, 255 Atlantic Avenue, Boston, four-page folder describing air-cooled gasoline engine and diaphragm pump mounted on wooden skid. The engine is mounted directly over the pump, making a light and compact outfit.

The Kilbourne & Jacobs Manufacturing Company, Columbus, Ohio, catalog 41, 6 x 9 in., 30 pages, illustrated. Describes standardized line of wheelbarrows and scrapers. Contains several tables and an index.

The Goulds Manufacturing Company, Seneca Falls, N. Y., bulletin 120, 10 x 7¾ in., 20 pages, illustrated. First of this company's bulletins on its line of multi-stage centrifugal pumps. Contains descriptions of various sizes and the adaptation of each. Several cross-sections and charts and diagrams.

Raymond Brothers Impact Pulverizer Company, Chicago, catalog 12, 64 pages, illustrated. Describes grinding, pulverizing and air-separating machinery for any material to be reduced to powdered form. Contains drawings of model installations and partial list of materials handled by the Raymond system.